JPRS-UEE-88-005
30 AUGUST 1988

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JPRS-UEE-88-005 *30 AUGUST 1988*

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PAL System Signal Decoder: Part I

81442673a Moscow RADIO in Russian
No 1, 1988, pp 27-29

[Article under the "Video Engineering" rubric by V. Ketners, Ogre, Latvian SSR]

[Text] The Elektronika VM/12 cassette video recorder [1, 2], manufactured by Soviet industry, can record and play back television signals formatted in accordance with the SECAM color television system, which prevails in the USSR, and the PAL system, used in many Western countries. However, in order to play back the programs recorded in these systems as a color picture on the screen of a Soviet television, (the latter must be equipped with an additional unit) the PAL system signal decoder. The schematic of a possible version of such unit, suitable for any given TV set, is shown in Figure 1. [Figure 1 not reproduced]

Before describing the operation of the decoder, let us recall what is constituted by a complete television signal of the PAL system. As is known, this contains a brightness (with blanking and synchro pulses) and a color (with color synchronization pulses) components. The second of these transmits color-ifference "blue" (B/Y) and "red" (R/Y) signals, formed (as is the brightness signal Y) by algebraic addition (in the appropriate ratio) of the primary color potentials: "green" (G), "blue"(B), and "red" (R).

The signals in the SECAM system are produced in identical manner, except in the PAL system these color-difference waves are sent simultaneously on a single subcarrier with 90 degree difference in phases, i.e., by the frame amplitude modulation technique in the SECAM system, they are sent in alternating lines on different subcarriers (4.25 and 4.406 MHz) with frequency modulation. Furthermore, to eliminate differential-phase distortions, the phase of the subcarrier of the color-difference "red" signal changes by 180 degrees from line to line. This feature is reflected in the name of the system: PAL (Phase Alternation Line). It must be noted that several modifications of the PAL system exist, differing in the subcarrier frequencies (4.43 or 3.58 MHz), the phases of the subcarriers of the color-difference signals, as well as the presence or absence of a delay line in the TV sets.

Television signals are recorded on video cassettes in the PAL/DL modification, using a subcarrier frequency of 4.43 MHz and requiring use of a delay line. This factor enables a more easy integration of the PAL and SECAM systems, since in the latter a delay line for the line length is mandatory. The delay line is compatible with devices providing algebraic addition of the potentials of adjacent lines, separating the color difference PAL signals in the TV set and eliminating their differential phase distortions. After such manipulation, the phase distortions are converted into amplitude distortions, manifested by a change in line brightness, which is much less noticeable than the color change observed in the case of phase distortions. In order to avoid other distortions of the color tones of the picture, the phase of the subcarrier waves in all synchronous color television detectors should be exactly (to within 5 degrees) equal to the phase of the modulated subcarrier of the received signal.

For fine tuning, as well as correction of phase change in the synchronous detector of "red" color difference potential, after the line synchro pulse (before the start of the next line) a spike of nonmodulated waves of the subcarrier corresponding to this line (8-10 periods) is added to the television signal. Thus, the complete television signals of the PAL and SECAM systems are handled identically in the TV set up to the instant of production of the direct and the delayed potentials. Thereafter, when the signals are being received in the SECAM system, these potentials are sent to the decoder of the TV set itself (electronic commutator). But if it is necessary to receive PAL system signals, the PAL decoder should be activated by the tumbler SA1 (Figure 1). This trips the relay K1, and the power supply potential is applied across the closing contacts K1.1 and the electronic filter (transistor VT17) to the elements of the PAL signal decoder. Contacts K1.2 connect another capacitor (C8) to the "clash" filter of the SECAM decoder, which is retuned to the subcarrier of the PAL system (4.43 MHz). After K1, relays K2 and K3 are tripped, and by contacts K2.1, K2.2, and K3.1, K3.2 the PAL signal decoder is connected to the TV set and the SECAM signal decoding circuits are disconnected.

It is possible, however, to connect the PAL decoder across diodes VD13-VD15 to the outputs of the flip flops (of the TV set's sensory program selector) activating the channels of the TV set and passing the signals of the PAL system. In this case, when the appropriate button or program selection sensor is depressed, a potential is applied to the base of the transistor VT16, opening it, which activates relay K1 and the entire PAL decoder unit. The direct signal from the TV set arrives at the base of the transistor VT3 of the emitter repeater, while the delayed signal arrives at the base of transistor VT1 of the paraphase amplifier. These two are added and subtracted in the resistive matrix R6, R7, R11-R13. Their relationship is established by the trimming resistors R1 and R10. As a result, two separate color-difference ("red" and "blue") signals with a mutual phase shift of 90 degrees (i.e., in quadrature) are produced at the outputs of the matrix, which are sent to the regulated amplifiers constructed from transistors VT2 and VT4, respectively. By adjusting the potential on their bases with the variable resistor R15, the desired picture saturation can be set.

It should be noted that, owing to the mutual compensation, the differential phase distortions arising in the coupling channel are considerably lessened in such signals. The emitter currents of transistors VT2 and VT4 flow through resistors R26, R29, the open transistor VT15, and the color diode HL1. Transistor VT15

switches the amplifiers in dependence on the signal being received. If it is a black/white picture, the transistors are closed and the decoder channels deactivated. But if it is color, the transistors are open and the formed signals are amplified. The amplifiers are loaded on the coils L1 and L4, resonating at frequency of 4.43 MHz. Resistors R23, R24, and R27 provide the necessary pass band of the amplifiers.

In the received PAL signal, the phase of the color-difference "red" potential varies from line to line by 180 degrees, whereas it should be constant for detection. Therefore, the channel of the "red" signal contains a paraphase amplifier built from the transistor VT8 and a commutator built from diodes VD1, VD2, to which are sent the opposite phase pulses of line duration from the symmetrical flip flop of the TV set. Opening in alternation, the diodes pass a signal with identical phase from the outputs of the amplifier to the input of the commutator. The emitter repeaters built from transistors VT9 and VT10 coordinate the output resistances of the previous stages with the input resistance of the synchronous detectors, which in the final analysis increases the saturation and improves the color transitions. The resulting color*difference "red" and "blue" signals, respectively, are sent to detectors built from diodes VD5, VD6 and VD7, VD8. The potential of the subcarrier oscillator is applied to the second inputs of the detectors. The loop L5C37 of the "red" detector is slightly mistuned from the resonance frequency 4.43 MHz and has a modest capacitive coupling (C38) with the loop L6C41 of the "blue" detector.

As a result, the detectors can detect signals with 90 degree phase shift, i.e., in quadrature. The output voltages of the synchronous detectors, including their constant components, are sent through the matching emitter repeaters (transistors VT11 and VT12) to the amplifiers of color-difference signals of the TV set. For certain TV set models, inverted output decoder signals are required. In this case, resistors R65 and R69 arejconnected (by removal of the jumpers) in the circuit of the collectors of transistors VT11 and VT12, respectively, and the output signals are picked off their collectors. The subcarrier oscillator is built from the transistor VT13, its frequency (4.43 MHz) being stabilized by a quartz resonator ZQ1. The frequency and phase of the subcarrier are set by the trimming capacitor C42 and resistor R44. The waves of the oscillator are amplified by a stage built from the transistor VT14, after which they are sent to the synchronous detectors and the automatic frequency and phase fine tuning system (APChF) of the oscillator.

The APChF system maintains the exact frequency and phase of the subcarrier, depending on the color synchronization signal (spike) contained in the received signals. This, in large measure, governs the quality of playback of the picture. The operation of the system is backed up by a gated spike discrimination stage (transistor VT5) and phase detector (diodes VD3 and VD4). The gating line synchro pulses from the TV set are sent to the spike discrimination stage. These open the transistor VT5 only during the closed segment of the line blanking pulse (immediately after the synchro pulse) in the received voltage. The latter is taken off the emitter repeater (VT3) of the direct signal channel and sent to the base of the transistor VT5. As a result, spikes are discriminated in the loop L7C23, whose amplitude on the collector of the transistor attains 20-30 V. For the rest of the time, the stage is closed by the voltage taken off the divider R18R19. The phase detector of the system is connected to the loop L7C23 across capacitors C22 and C24. The diodes VD3 and VD4 of the former receive, across capacitor C30, the subcarrier potential from the quartz oscillator. If the frequencies and phases of the spike and signal waves of the subcarrier do not coincide, a low frequency voltage is produced in the detector. This is applied to the varicap VD10, which balances the frequency and phase of the subcarrier and the spike. Since the oscillations in the latter are phase-manipulated, there will be bipolar pulses of half-line frequency (7.8 kHz) at the output of the detector. However, the integrating capacitor C31 averages these, so that they do not affect the operation of the APChF system.

The circuit R51C32 eliminates stray low frequency oscillations from the latter. The capture band of the system is several hundred Hertz, quite satisfactory for a stable operation. The pulses of half line frequency produced in the phase detector of the APChF system are used in the decoder for recognition of the color picture signals, activation of the decoder channels, and correction of the switching phase of the symmetrical flip flop in the TV set. These are taken off the resistors R47, R48 and are sent across the emitter repeater built from transistor VT6 to the resonance amplifier built from transistor VT7. This is loaded on the loop L10C15R32, which is tuned to the half line frequency. These pulses excite sinusoidal oscillations in the latter, which persist for several lines. Thanks to this, the amplifier has good noise immunity. The signal taken from the latter is rectified by diodes VD11, VD12. The dc voltage thus produced on the capacitor C33 opens the transistor VT15 and, consequently, activates thejdecoder channels. When receiving black/white picture signals in which there are no spikes, there is no potential across capacitor C33, the transistor VT15 and the decoder channels are closed. Since the level of interference in these signals may be large, a modest voltage of half-line frequency may be created in the loop L10C15R32, slightly opening the decoder. To avoid this, a light diode HL1 is included in the emitter circuit of the transistor VT15, creating a nonlinear dc feedback. Furthermore, this indicates the reception mode of the color picture signals. At the same time, the signal from the amplifier built from transistor VT7 is sent across the circuit C26R54 to the symmetrical flip flop of the TV set and corrects (if need be) its switching phase.

We should also discuss the loops L2C5 and L3C6, hooked up at the input of the emitter repeater built from the transistor VT3. These are necessary when the

decoder is working with the BTsI-1 integrated color unit. Actually, the band filter picking out the color signals in this unit has an amplitude/frequency curve with less steep slopes than the filters of other units of similar function. Hence, oscillations around 3 and 5.5 MHz in frequency are sent to the decoder. The voltage of around 3 MHz (video signal component) produces a green tint of the vertical brightness transitions of the image. The signal of frequency 5.5 MHz (soundtrack carrier frequency in the PAL system) creates beats with the subcarrier (4.43 MHz) of color signals in the synchronous detectors. The voltage of the difference frequency (1.07 MHz), however, create a moire on the color bands of the image, shifting in time with the soundtrack. Rejector circuits eliminate these defects. We should also point out that, since the soundtrack signal in the PAL system is sent on carrier frequency of 5.5 MHz (unlike the SECAM system, in which this carrier is 6.5 MHz), the loops tuned to frequency of 6.5 MHz (in the video amplifier, the soundtrack IF amplifier and frequency detector) in a TV set working with the PAL decoder must be retuned to 5.5 MHz. To do this automatically, it is advisable to connect additional capacitors (e.g., by the contacts of relays controlled by the power supply voltage of the decoder) to such loops when receiving PAL signals.

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12717

PAL System Signal Decoder: Part 2

81442673b Moscow RADIO in Russian
No 2, 1988, pp 30-32

[Second part of article under the "Video Engineering" rubric by V. Ketners, Ogre, Latvian SSR]

[Text] The decoder uses fixed resistors MLT, trimming SP [variable resistors] and a variable SP-1 (R15), fixed capacitors of series KT and KM, a trimming KPKM (C42). The capacitors C47 and C48 can have a capacity of 120-240 pF. All the relays are RES-9 of any given certificate, such as RS4.524.200 or RS4.524.201. The varicap VD10 is KV102 or D901 with any given letter indexes. It should be noted that no special requirements are placed on the components of the decoder, and they can be replaced successfully by any others of corresponding ratings and dimensions, if they can be installed on the printed circuit board. The decoder can use the quartz resonator VM-2 (ZQ1) from the Elektronika VM-12 video recorder (in this case, the loop L8C42 is eliminated, and the leads of the resistor R52 and the varicap VD10 are connected directly to the lead of the resonator) or a different resonator of frequency 4.43 MHz, such as one from the Kvarts-44 set. The coils L1-L9 are wound with wire PELShO 0.1 on 4-section frames of diameter 4-6 mm from the factory coils of heterodyne circuits of transistorized receivers.

The tuners are from the IF or HF circuits of these. The coils L1 and L4 each contain 4x25, L2 and L3 each 4x15, L5*L7 each 4x20 (with tap in the middle), L8 3x15+20 and L9 contains 4x10 turns. Coil L10 is wound with wire PEV-2 0.08 on a frame of diameter 4 and length 17 mm with end pieces of diameter 13 mm before being filled. In place of this, it is possible to use the circuits 3L1 from color or 4F1 from black/white TV sets, along with capacitors (so)called "ringing" circuits.

The windings of the choke coils L11 and L12 are arranged on ferrite cores of diameter 3 and length 10 mm (from the tuners of the IF circuits of transistorized receivers) and each contain 40 turns of wire PEL 0.1.The decoder is assembled on a printed circuit board of dimensions 175x89 mm of foil-clad glass textolite, 1 mm thick. A diagram of the board and the arrangement of elements on it are shown in Figure 2. [Figure 2 not reproduced] In accordance with the recommendations in the first part of the article, the resistors R65 and R69 should be closed into a circuit with jumpers. The schematic of the decoder does not show the filtering capacitors of the powerjsupply circuit, C54 and C55: the former has a capacity of 0.01, the second 50 mcF (voltage rating of the latter, 30 V). The light diode HL1, located on the circuit board, can be moved to the front panel of the TV set, in which case it will indicate whether the PAL decoder is on. The variable resistor R15 "Saturation" and the tumbler SA1 "Manual PAL turn-on" can be placed anywhere convenient to the control of the decoder. The relay K1, diode VD16 and capacitors C8, C53 are arranged in the TV set alongside the "Clash" circuit.

For more stable operation of the decoder, this circuit must be shunted by a resistor (in parallel with the capacitor C8-, widening its frequency pass band to at least +1 or)1 MHz. Although the decoder can be used in any given color TV set, an individual approach is needed in the connection to the input and the output signals, because of the difference between the latter. In any given case, normal operation of the decoder requires signals whose amplitude is identical and approximately equal to 1 V. This is adjusted by the trimming resistors R1 and R10 and checked by oscillograph at resistor R5 and the cursor of resistor R10 (inputs) and at the emitters (or collectors when inverted signals are used) of transistors VT11 and VT12 (outputs). Positive pulses of the back motion of the line sweep are used as the synchro pulses required to discriminate the spikes from the PAL signal.

These are taken off the low-voltage winding of the output transformer. The pulse amplitude should be 10-50 V. Nor is it easy to supply the pulses correcting the switching phase of the symmetrical flip flop of the TV set, since this phase is adjustedjeither in terms of the rising or the falling flank of the pulse, while it may also be necessary to change its level. To increase the level, the resistance of R54 should be decreased; it may even be necessary to remove resistor R32. When the decoder is connected to tube TV sets, the components R56, R57, R65, R66, VT11 and R59, R60, R69, R70, VT12 are removed.

The bias voltages needed for normal operation of the amplifier tubes of the color-difference signals are supplied to the middle leads of the coils L5 and L6 of the decoder. These are taken off the points of connection of the resistors R63, R64 and R67, R68, together with the color*difference signals produced in the synchronous detectors, after changing the commutation of the PAL and SECAM signals in the necessary fashion. When tuning the decoder, a 7-color band signal form a generator of television test signals coded in the PAL system is applied to the input of the TV set. All circuits of the decoder, except L2C5, L3C6 and L10C15 are rough-tuned in advance to a signal of frequency 4.43 MHz. The loop L10C15 should be tuned to frequency 7.8 kHz. The loops L2C5 and L3C6 are connected and tuned after the decoder has been tuned. Next, after making the circuit of the capacitor C51, it is necessary to turn on the decoder and, by connecting an avometer to the loops L5C37 and L6C41 (across a capacitor of 10 pF), tune them to maximum voltage. After this, a (rough) lock-on mode of the APChF [automatic frequency and phase fine tuning] system is achieved by moving the tuner of the coil L8. If this cannot be done, then the capacitor C42 is trimmed. The exact frequency of the oscillator is set by the trimming resistor R44. When the "blue" gun of the kinescope is turned on, four blue bands should appear on the screen. A symmetrical lock of the APChF system is achieved by the tuners of the coils L7 and L8. Next, turning on the "red" gun of the kinescope, maximum brightness of the red bands is achieved with the tuner of coil L5. After this, all guns of the kinescope are turned on. A stable image of 7-color bands should appear on the screen. If the arrangement of the colors is not suitable, the wires connecting the outputs of the symmetrical flip flop should change places, and then the best color transitions between the bands should be achieved by the tuners of coils L1, L4-L6. A four-line raster structure may be observed in the resulting image, manifested by different brightness of adjacent lines and a tinting of the gray segments of the picture. Such effect is produced by phase distortions in the transmission/reception channel and time inaccuracy of the delay line in the TV set.

The discrepancy in line brightness can be fixed by slightly changing the position of the cursors of the trimming resistors R1 and R10, while the gray picture segments can be corrected by moving the tuner of coil L8 (while watching for symmetrical lock-on of the APChF system). If this cannot be done, it is necessary to select a delay line from the ULZ64-4, the ULZ64-5, or to use the very serviceable line from the ULZ64-8. Next, after connecting the avometer (across a capacitor of 0.01 mcF) to the collector of transistor VT7, the loop L10C15 of the discriminationjdevice is tuned exactly in terms of maximum voltage across it. After this, the operation of the discrimination device is checked in presence of interference.

When receiving PAL system signals (the jumper should be removed from capacitor C51), the decoder should be smoothly activated (the voltage at the collector of transistor VT15 should decrease nearly to zero) and the symmetrical flip flop should be switched in the necessary phase. Occasionally, it may be necessary to match up appropriate resistors R53 and R54. When using the decoder in a TV set with BTsI-1 color unit, loops L2C5 and L3C6 are connected and tuned to frequencies 5.5 and 3 MHz, respectively. While tuning the first of these, the "moire" type distortions of frequency 1.07 MHz, varying in time with the soundtrack, are corrected. While tuning the second, green tint is eliminated from the vertical brightness transitions. Of course, modern electronic switching could have been used in the decoder for connection to the TV set, but this is too rigidly dependent on each particular model of TV set.

Therefore, the decoder uses ordinary relays for this purpose. An even greater simplification of the commutation is possible by a selector switch (P2K) with appropriate number of contact groups (connection wires up to a length of 50 cm produce no noticeable distortions). Finally, returning to the need to fine tune the loops tuned to frequency of 6.5 MHz (the second intermediate of the soundtrack, as mentioned in the previous part of the article), we should note that the carriers of the video signal and the soundtrack signal when recording TV programs in the PAL system may be separated precisely by this intermediate frequency, and then there will be no need to fine tune the loops.

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Analytical Determination of Coordinates of Perceived Three-Dimensional Space

18600014a Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 87 pp 23-26

[Article by G. V. Mamchev, Novosibirsk Institute of Electrical Communication Engineering]

[Abstract] Perception of a stereoscopic TV image through binoculars is analyzed on the basis of a model of such an image comprising a set of discrete points, correct determination of their coordinates presenting a major design problem. Geometrical calculations are made for perception of the three-dimensional screen space, subject to eye-physiological constraints, and for perception of the three-dimensional forescreen space free of these

constraints. Into account are taken the allowable depth of a physical three-dimensional space as well as the relation between a convergence plane and an accommodation plane. Figures 1; references 9: 7 Russian, 2 Western.

02415/09599

Equipment for Transmission and Reception of Digital Television Signal Over Fiber-Optic Communication Lines

18600014b Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 87 pp 18-23

[Article by E. B. Makhmudov and A. A. Chesnokov, Kibernetika Uzbek Scientific Production Association]

[Abstract] Equipment for transmission and reception of a complete SECAM digital color TV signal over a fiber-optic communication line is described which combines a high performance margin with maximum simplicity. Transmitter and receiver are schematically similar, each consisting essentially of two parts. One part comprises a buffer memory for the luminance signal component and a controlled memory for the chrominance signal component. The other part processes the luminance component and the second chrominance component. The equipment includes an analog-to-digital converter in the transmitter, a digital-to-analog converter in the receiver, OR and NOR logic with triggers, AND coincidence circuits, counters, and line-pulse synchronizers. The equipment features a high degree of circuit integration, with the buffer memories built on series K565 chips, the converters built on series K1107PV and on series K1118AP1 chips respectively, and most other devices built on series K500 or series K100 chips. Figures 2; references 7: 6 Russian, 1 Western (in Russian translation).

02415/09599

Subjective Frequency Characteristics of Headphones

18600024a Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 87 pp 13-15

[Article by Yu. A. Indlin, All-Union Scientific Research Institute of Cinematography]

[Abstract] The subjective frequency characteristic of several domestically manufactured headphones was measured by the method of direct comparison in a free field, in accordance with the applicable International Standard, and then normalized according to the IEC Standard 581-10-1986. Professional headsets 12A29/33/35 as well as consumer headsets TDS-5/7/9A/10/13-2/14/20 and TPS-1 were included in this evaluation. A free field of 70 dB intensity was produced in an anechoic chamber and a mixture of 3-octave pink noise covering the 500-16,000 Hz frequency range with a sequence of 50-500 Hz tones was used as test signal, that sequence of tones yielding more reliable and accurate readings at the low end of the frequency characteristic. The objective frequency characteristic of each headset was also measured, for reference, using a Bruel & Kjaer No 4150 artificial ear and a DB0843 adapter-disk with each earphone. Most uniform was found to be the subjective frequency characteristic of a TDS-14 headset, those of TDS-5 and TDS-7 headsets being somewhat more nonuniform and those of all other headset being not only much more nonuniform but also much more different than their respective objective frequency characteristics: an indicator of faulty design or construction. Figures 3; references 5: 2 Russian, 3 IEC.

02415/09599

Computer-Aided Production of Animated Cartoons

18600024b Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 87 pp 16-20

[Article by E. K. Agadzhanyan and V. V. Bykov, All-Union Scientific Research Institute of Television and Radio Broadcasting]

[Abstract] A computer has been successfully used for aiding production of animated cartoons from stationary frames. The electronic apparatus for this purpose in the Vision 4 system developed by PVK and PIK in West Germany includes a computer controlling the operation, a memory on magnetic disks, a black-and-white screen displaying the menu for the film editor, and a color monitor displaying the images, also a digital mixer of incoming and internally generated images. Various modes of recording and playback by means of such electronic videographics are possible, with the effect of movement achievable by color cycling, by cellularized animation, by adaptive animation, by coordinate transformations, or by frame-to-frame animation. A further development is three-dimensional animation with the aid of stereovideographics such as FGS-4000 (Bosch GmbH, FRG), DPS-1 (Dubner, Co., USA), or PM 3000 (Cubicomp Co., USA). Simulation is based here on representation of surfaces in polygonal form and of soft objects as arrays of controllable spherical dots. Depending on the intricacy of a frame, several minutes to several hours of computer time may be required for its formation. While greatly aiding the artist, a computer cannot quite replace his or her creativity. It is nevertheless adequate for educational and popular-science cartoons. References 9: 3 Russian, 6 Western.

02415/09599

Methods of Designing Compatible High-Definition TV Systems

18600024c Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 10, Oct 87 pp 21-25

[Article by A. A. Maksakov and T. G. Sorokina, Moscow Institute of Electrical Communications Engineering]

[Abstract] Existing and proposed high-definition TV systems operate with a larger number of scan lines and a wider frequency band of the luminance signal than

provided for in standard color television systems such as SECAM, PAL, or NTSC. For this reason, an HDTV system will be regarded as compatible with a standard system as long as normal reception on conventional TV sets either directly or after appropriate preliminary conversion is feasible. Accordingly, there are three methods available for designing a compatible HDTV system. One method is based on generating and transmitting the standard total color TV signal, then converting it into a HDTV signal in the HDTV receiver. Another method is based on generating and transmitting the total HDTV signal, then converting it into a standard color TV signal in the conventional receiver. The third method, most preferable, is based on generating and transmitting a signal incompatible with either of the two systems, then converting it into both a HDTV signal and a standard color TV signal. In this case there must actually be generated three signals: total standard color signal, total HDTV signal, and a CHDTV (compatible high-definition TV) signal for generating both the other ones. The principle of the third method is demonstrated on a typical example of matching a HDTV system with the NTSC standard system. There follows a rough comparative design and performance analysis indicating advantages of the third method in terms of apparatus simplicity and reception quality. On the other hand, however, only the first method does not require major reconstruction of television receivers and only the second method, though with use of still costly digital standard converters, would allow adoption of a single worldwide HDTV standard. Figures 5; references 10: 2 Russian, 5 Western, 3 CCIR.

02415/09599

UDC538.566

Variations of the Tropospheric Propagation Range of Ultrashort Radio Waves Above the Sea

18600067a Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 2, Feb 88 (manuscript submitted 12 Nov 1986) pp 238-240

[Article by A. R. Gliner, S. N. Krivonozhkin and B. M. Shevtsov, Pacific Ocean Oceanographic Institute, Far East Scientific Center, USSR Academy of Sciences, under the "Brief Communications and letters to the Editor" rubric]

[Text] In connection with the development of beyond-the-horizon radar, communications and remote sensing of the atmosphere, the problem of predicting the tropospheric propagation range of US [ultrashort] radio waves has assumed great practical importance. Therefore, the dependence of radio signal characteristics on the propagation conditions has been investigated over different radio paths (see, for example, [1-3]). Of special interest are routes over oceans, where the conditions for long-range waveguide propagation can occur. However, there is not yet sufficient data on how much and in what manner the radio-wave propagation range varies in the marine troposphere in different geographical regions, depending on the water and weather conditions. The lack of sufficient information on this problem is linked with the difficulties of making marine measurements and of organizing continuous observations. Satellites are a possible radiation source for such observations, since the satellite network has expanded considerably in recent times. The most suitable satellites for this purpose might be weather or navigation satellites, which emit radiation continuously and operation in all regions of the earth. However, in order to investigate the effects of radio-wave refraction and diffraction in the bottom, near-water layer of the troposphere and to record the variations in radio-wave propagation range linked with these effects, the satellite observations must be made at small angles of elevation under conditions of very unstable radio communications, which poses considerable methodological difficulties. The present article discusses a measurement method and the results of observations of tropospheric variations in the propagation range of US radio waves above the ocean. The experiments were performed in the northern Indian Ocean in May and December with rising and setting satellites of the NOAA system.

The radio-rising or -setting of a continuously emitting satellite occurs when the satellite intersects the radioumbra boundary, which is curved as a result of the normal refraction of rays in the troposphere. At a satellite emission frequency of about 137.5 MHz, ionospheric refraction effects are much weaker than tropospheric effects [4], and can be disregarded. The angle of refraction of the rays can be determined easily using the following model of tropospheric permittivity [model not reproduced] where R is the earth's radius; v_o approximately equal to 5×10^{-4} and h_o approximately equal to 8 km. If h_o much less H, where H is the satellite orbit height (H approximately equal to 850 km), when the satellite elevation angle is zero, the refraction correction factor gdgf for the elevation angle can be determined as [4] within the framework of perturbation theory for the ray equations of geometrical optics. For the above values of the parameters, gdgc approximately equal to -0.88×10^{-2}. The coordinate of the satellite along the earth's surface between the points where the satellite intersects the geometric horizon (line of sight) and the radiohorizon changes by 56 km, which corresponds to a time change of gdt = gdx/V, where V is the velocity of the satellite coordinate (V approximately equal to 6.5 km/s), so that gdt approximately equal to 8.6 s. The position of the radioumbra boundary can be calculated by introducing the effective radius of the earth [5]. In the region of the umbra boundary, the form of the field-attenuation function changes depending on the propagation conditions [5, 6], and the distance to the initial level at which radio communications is established varies. The aim of the present work is to investigate the statistical characteristics of these variations.

The weather satellites of the NOAA system emit continuously on frequencies of 137.5 and 137.62 MHz. They orbit on nearly circular, circumpolar orbits with a height of H approximately equal to 850 km, an orbital period of about 100 min and an angle of 9° between the orbital plane and the earth's axis. Precise orbital data are reported by teletype from ground stations.

The satellites transmit information signals at about one-second intervals. Using a threshold device in the receiver to determine the first or last signal during a radio contact, the moment t when the satellite crosses the radiohorizon can be determined with an accuracy of 1-2 s. The satellite radio signal level in the penumbra region, averages with a time constant of 1 s, is shown in Fig 1. Using the above-described method, a radio-signal level of about 2 gmV was used to determine the moment t when the satellite crosses the radio horizon. The moments t_o that the satellite crosses the line-of-sight boundary can be calculated geometrically from the orbital data. Thus, the variations of the radio-communications range $gdx = V(t_o - t)$ were determined in the experiment. The distribution of the measured radiocommunications-range variations observed in May is shown in Fig 2; the December distribution is shown in Fig 3. The means of these distributions are in good agreement with the above calculations of the position of the radioumbra boundary. The standard deviations for these distributions are equal to 77.7 km and 75.4 km, respectively. The distributions are noticeably asymmetric; in addition, they reveal a structure which might be linked with oscillations of the field-attenuation function. We note that in order to verify the method, measurements were made of the variations of the radiocommunications range separately for satellite rises and sets, as well as in

southerly and northerly directions. No significant differences were noted in the distributions of measurements. The measurement results show that anomalously high deviations of the radio-wave propagation range, which might be linked with the occurrence of waveguide structures, occur fairly rarely at these latitudes, and do not exceed several percent of the total number of measurements. Small deviations of the radio communications range from the mean value comprising the main part of the observations can be attributed to sub- and superrefraction variations in the troposphere. The correlation coefficient between the measurements at the moments of satellite rising and setting in May was 0.1, and in December was 0.4. The correlation coefficient between variations of the radiocommunications range and changes in the humidity gradient in the atmospheric layer up to 20 m did not exceed 0.1.

The authors wish to express their deep appreciation to A. S. Gurvich and V. I. Klyatskin for useful discussions of the results.

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12595/9274

UDC 535.51

Electromechanical Light Polarization Modulator

18600022e Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 10 Nov 86) pp 36-37

[Abstract] A. I. Penkovskiy, D. d. Khamelin, R. T. Afanasenko and I. F. Munasipov]

[Abstract] Quarter-wave plates with magnetooptic (MM) and electrooptic (EM) modulators are usually used for modulation of the polarization azimuth and phase difference in photoelectric ellipsometers. However, MM are complex and consume excessive power while EM are expensive and difficult to regulate. Sometimes an electromechanical modulator can be used for the polarization but then another modulator is necessary for the phase difference. The optimal solution is a polarization modulation device utilizing a quarter-wave plate swinging in its plane which was previously used in domestic interferometers but specific details as to the design of the devices is not available. A description is given of the design of a simple electromechanical modulator for simultaneous modulation of polarization and phase difference. The design is based on the fact that there is simultaneous variation of polarization and phase difference when deviation of the crystallographic axes of the quarter-wave plate relative to linearly polarized light occurs with small amplitude deviations of the plate. The design was experimentally used in a polarization reflectometer. Figures 2; references: 5 Russian.

12497/06662

Scattering of Electromagnetic Waves By Sound in Problems of Atmosphere Probing: Review

18600015a Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 4, Apr 87 (manuscript received 7 Apr 86) pp 451-473

[Article by A. S. Gurvich, A. I. Kon, and V. I. Tatarskiy, Institute of Atmospheric Physics, USSR Academy of Sciences]

[Abstract] The method of radioacoustic atmosphere probing is closely correlated with the theory of scattering of electromagnetic waves by sound, as research and developments over the past 25 years demonstrate, the gist of radioacoustic probing being injection of a sound pulse of given duration into the atmosphere so as to cause space-time modulation of the air density and scattering of electromagnetic waves. Following a review of relevant physical laws on the basis of a simple ideal model in the Born approximation, backscattering of an electromagnetic pulse by an acoustic pulse train as a result of their interaction in the far field is considered and the frequency spectrum of the echo signal is calculated on the basis of the applicable Maxwell field equations. Particularly interesting are the case of interacting pulses with Gaussian envelopes and the case of interacting pulses of infinite durations. The signal power is calculated next, examination of the signal intensity distribution as well as of the signal phase distribution revealing a phenomenon similar to phase conjugation. The performance characteristics of a three-antenna radioacoustic probing system are established, taking into account diffraction but ignoring such factors as atmospheric turbulence, wind drift, temperature gradient, and, most importantly, nonlinear sound absorption. Figures 4; references 25: 20 Russian, 5 Western (1 in Russian translation).

02415/09599

Use of Reflected Signal for Adaptive Control of Light Beam Wavefront
18600015b Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 4, Apr 87 (manuscript received 17 Jun 85) pp 505-515

[Article by V. A. Trofimov, Moscow State University]

[Abstract] A new approach to adaptive control of the light beam wavefront is proposed for compensation of thermal and Kerr defocusing, namely use of the signal reflected by the receiver and only data on the quality criterion it contains. Potentially convergent iterative algorithms of aperture probing are constructed on the basis of the fundamental equations of light propagation through a nonlinear medium, in the nonaberrational approximation first, for wavefront optimization by both beam focusing and slope control. Compensation of beam divergence in a thin nonlinear layer and in a thick layer is added. There follows a design and performance analysis of a mirror, without or with shape constraints, for dynamic control. Wavefront control of light beams with Gaussian and hyper-Gaussian initial profiles is considered, whereupon both convergence and stability of phase conjugation are estimated. References: 16 Russian.

02415/09599

Diffraction of Electromagnetic Wave by Sphere. Summation of Mie Series
18600015c Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 4, Apr 87 (manuscript received 2 Jul 85) pp 522-528

[Article by E. M. Hynninen, V. V. Kirillov, and V. N. Kopeykin, Leningrad State University]

[Abstract] For solution of the problem of diffraction of electromagnetic waves by a sphere such as Earth, an extension of the Mie problem of light scattering by spherical colloidal particles, a new method is proposed for summation of functional series absolutely divergent at the boundary of the convergence circle when both source and observation point are located on the surface of the sphere. The method is demonstrated on summation of a Taylor series and of zonal harmonics, before it is applied to an electric dipole on a conducting sphere and on a dielecteric sphere. Already two successive transformations are found to yield a satisfactory asymptotic approximation. Calculations programmed for a computer reveal the "microstructure" of the dipole field in each case. Figures 7; references 5: 2 Russian, 3 Western.

02415/09599

Resonant Scattering of Radio Waves in Acoustically Perturbed Ionosphere
18600033a Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 29 Jul 85) pp 578-584

[Article by V. V. Plotkin and N. I. Izrayleva, Institute of Geology and Geophysics, Siberian Department, USSR Academy of Sciences]

[Abstract] The effect of an acoustic perturbation of the ionosphere on the propagation of an electromagnetic wave such as a probing radio wave is analyzed, considering that an acoustic wave produces in the ionosphere an electron concentration "lattice" which travels with it. For simplicity, the electromagnetic wave is assumed to be a plane one and the terrestrial magnetic field is ignored. Solution of the wave equation, for an electromagnetic wave first in a quiescent medium and then in an acoustically perturbed one, reveals that such a "lattice" scatters the probing wave with the Doppler shift of its carrier frequency dependent on the spectrum of the acoustic perturbation and the amplitudes of harmonic components in its Doppler spectrum dependent on the degree of scattering by corresponding acoustic "lattice" harmonics. As resonance is approached with sufficiently high acoustic "lattice" harmonics, appreciable reflection of a radio wave is found to be possible only at a certain sound intensity and thus "lattice" amplitude above a threshold level. References 15: 12 Russian, 3 Western (2 in Russian translation).

02415/09599

Fluctuations of Light Intensity in Atmospheric Channels Induced by Intense Radiation Pulses
18600033b Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received after revision 3 Mar 86) pp 585-591

[Article by V. A. Banakh, V. L. Mironov, I. N. Smalikho, and R. Sh. Tsvyk, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences]

[Abstract] Propagation of radiation pulses from a power laser through a turbulent atmosphere and attendant formation of a refractive channel with transverse index gradient by a gas (aerosol) acoustothermodynamic mechanism are considered, a time correlation being established between resulting weak light-intensity fluctuations and random shifts of a probing light beam which propagates collinearly with the laser beam. Figures 3; references 8: 7 Russian, 1 Western.

02415/09599

Utilization of Linear Electrooptic Effect for Diagnostic Measurements of Microwave Radiation

18600033c Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 16 Jul 85) pp 613-618

[Article by Yu. N. Berozashvili, S. Z. Machavariani, A. G. Natsvlishvili, and A. A. Chirakadze, Tbilisi State University]

[Abstract] Diagnostic measurements of microwave radiation by a new method is proposed, namely on the basis of the linear electrooptic effect rather than by conventional voltmeter and Hall methods. Electric and magnetic interference as well as temperature dependence are minimized by way of complete galvanic decoupling, which also eliminates contacts and thus improves reliability, with use of a high-resistivity low-loss semiconductor or dielectric so that absolute power measurement without heating of the material becomes possible. The gist of this method is modulation of light passing through an electrooptic crystal by the microwave radiation. The modulation depth depends on the crystal dimensions and orientation as well as on the refractive index and the electrooptic, also on the electric field intensity in the crystal. Highly suitable for this method is a GaP crystal with cubic symmetry and without inversion center, isotropy of its optical properties greatly facilitating alignment of the optical system while its very high electrical resistivity and very low dielectric loss tangent enabling it to withstand pulses of up to 250 kW power and up to 2.5 gms duration. Such a crystal in the form of a parallelepiped is placed inside a rectangular waveguide with metal walls, at the center and filling the cross-section, between a polarizer before and an analyzer behind followed by a photoreceiver. Such an instrument was tested experimentally on nearly square radio pulses from a microwave oscillator with a repetition rate of 9.45 GHz, their power and duration being varied over the 0.5-90 kW range and the 0.5-2.5 gms range respectively. The source of modulated light was an LG-126 laser and electric signals generated by the photoreceiver were sent to an oscillograph with a stroboscopic analog-to-digital converter. The instrument was checked against a standard calorimetric one. The results indicate that such an instrument is sufficiently linear and sensitive for accurate determination of microwave field parameters from its readings in accordance with simple formulas. Figures 5; references 5: 4 Russian, 1 Western.

02415/09599

Diffraction of Plane Electromagnetic Wave by Array of Dielectric Cylinders Consisting of Coaxial Core and Shell Each

18600033d Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 24 Jun 85) pp 637-642

[Article by F. G. Bogdanov, G. Sh. Kevanishvili, and M. N. Chikhladze, Georgian Polytechnic Institute]

[Abstract] A linear periodic array of identical infinitely long parallel circular cylinders (period d) consisting of coaxial core (radius b, dielectric permittivity ge_2, magnetic permeability gm_2) and shell (inside radius b, outside radius ga, dielectric permittivity ge_1, magnetic permeability gm_1) is considered on which an either E-polarized or H-polarized electromagnetic wave (wavelength gl) impinges obliquely (incidence angle gv). Both the multipole spectrum and the diffraction spectrum of the scattered field are calculated, for determination of the fields inside both dielectric media of the cylinders and the transmission coefficient as a function of parameters ge_1, ge_2, $s = 2\ ga/d$, $D = d/gl$, gv. Numerical solution of the infinite Fredholm system of algebraic equations for the coefficients in the field equations, by the method of reductions on a BESM-6 high-speed computer, reveals that the diffraction characteristics of such an array depend only quantitatively but not qualitatively on the polarization of the incident wave. Such an array is also found to have resonance characteristics with respect to all given parameters and the resonance frequency to rise as any of them increases. Total transmission or reflection occur within the single-wave range. In the multi-wave range, meanwhile, the dispersion curve breaks at a sufficiently large D, this break becoming sharper as s, ge_1, ge_2, gv increase. In the long-wave approximation (D is considerably less than 1), moreover, such an array is perfectly transparent throughout the entire range of each other parameter. It is therefore possible to design such an array for smooth variation of its diffraction characteristics. Figures 5; references: 3 Russian.

02415/09599

Dislocations of Wavefront Surfaces Upon Reflection of Radio Signal by Ionosphere

18600033e Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 18 Feb 86) pp 669-671

[Article by T. A. Gaylit, V. D. Gusev, and M. I. Ivanov, Moscow State University]

[Abstract] A special multiperiod 0-2 gpn phase meter feeding signals to both inputs of an oscillograph, one of them a sawtooth sweep voltage, is used for recording and measuring very large jump changes in the difference between the phases of a radio signal at two zero-crossover points in space after such a signal has been reflected by the ionosphere. Experiments with such a phase meter were performed in three latitudinal radio channels, two of them 100 km long and one 1,400-2,300 km long. The transmitter operated in the pulse mode for the two short channels and in the continuous-wave mode for the long one. In one short channel a change of the operating frequency ensured reception of a split signal with an extraordinary magnetoionic component or of a simple signal with two ordinary magnetoionic components as in the other two channels. In the other short channel was recorded a one-jump simple signal reflected by the ionospheric F-layer and in the long channel was possible reception not only of a one-jump simple signal but also of a multimode signal. The results can be interpreted in

terms of dislocations of wavefront surfaces, upon reflection by the ionosphere, a concept borrowed from the theory of a spatially nonuniform laser radiation field. They can be used for study of the fine structure in the diffraction pattern of a scattered field and thus measuring the dimensions of ionospheric inhomogeneities. Figures 2; tables 1; references: 3 Russian.

02415/09599

Anomalous Absorption of Probing Radio Waves by Sporadic Layers in E-Region of Ionosphere

18600033f Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 5 May 87) pp 671-673

[Article by G. N. Boyko, V. A. Zyuzin, and S. A. Metelev, Scientific Research Institute of Radiophysics]

[Abstract] Experiments performed in 1985 in the Sura facility concerning perturbation of the ionosphere by high-intensity short-wave radiation revealed frequent appearance of sporadic layers in the E-region and a weaker reflection of probing radio waves. The pumping waves had a power of approximately 150 MW and a frequency of 4.785 MHz, the Sura transmitter operating intermittently over 20 s periods with 40 s pauses and its antenna having a vertical radiation pattern. The probing waves were formed in the Sura test stand by pulses of 0.6 MW average power and 150 gms duration with a repetition rate of 100 Hz. The anomalous absorption of radio waves by these sporadic layers, obviously the cause of their weaker reflection, is most likely attributable to development of small-scale nonuniformities of electron concentration in the ionospheric plasma as a result of its heating, these nonuniformities extending in the direction of the geomagnetic field. The authors thank L. M. Yerukhimov for helpful discussion of the results. Figures 2; references 6: 5 Russian, 1 Western.

02415/09599

Experimental Study of One Anomaly of Light Scattering Pattern in Scattering and Absorbing Medium

18600033g Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 5, May 87 (manuscript received 13 May 86) pp 679-680

[Article by V. G. Gavrilenko and S. S. Petrov, Gorkiy State University]

[Abstract] A laboratory experiment with light passing through a turbid medium has confirmed the possibility, theoretically predicted in the low-angle approximation, that normal absorption of light will not narrow down but anomalously broaden the scattering pattern. The experiment was performed with coherent light of gl = 1.06 gmm wavelength forming a rectangular beam with 10 x 15 mm^2 cross-section and passing through a cell with water in pulses of 1 J energy and 30 ns duration at a repetition rate of 0.5 Hz. After traversing a 4.5 cm long compartment with clear water without being scattered, the light beam continued through another compartment containing a strained oat brew to act as scatterer and a nigrosine dye to act as absorber. The condition necessary for the said anomaly to occur had been found to be a strong asymmetry best ensured by oblique incident of light and its subsequent refraction at a wide angle with minimum reflection. This was achieved with a cell having right-triangular glass prisms as front wall and back wall. Measurements were made with conventional scanning and recording devices. Numerical integration of the recorded scattering indicatrix revealed that approximately 70 percent of the incident energy had been scattered at angles smaller than 6.5 degrees. The authors thank N. S. Stepanov and L. S. Dolin for discussion, S. V. Gaponov for providing equipment, and D. G. Volgunov, V. A. Odnosevtsev, and S. N. Mensov for assistance in setting up the apparatus. Figures 5; references: 6 Russian.

02415/09599

Second-Order Spectrum of Radar Signal Reflection by Sea Surface

18600035a Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 6, Jun 87 (manuscript received 15 Jul 85) pp 687-696

[Article by A. S. Bryukhovetskiy, Institute of Radiophysics and Electronics, UkSSR Academy of Sciences]

[Abstract] Scattering of a radar signal by the sea surface upon glancing incidence is analyzed and the second-order spectrum $S_2(gq) = S_{13}(gq)$ plus $S_{22}(gq)$ of the echo signal, including up to third-order perturbation terms, is calculated according to the theory of small perturbations. The antenna is assumed to have a Gaussian radiation pattern and to transmit a vertically polarized radio pulse with Gaussian time envelope. The sea surface is assumed to remain quasi-steady during the signal period. Calculations are based on applicable Leontovich boundary conditions and Maxwell equations, with series expansion in a small parameter and Fourier integral representation of field fluctuations. Some assumptions made by D. E. Barrick are waived and, consequently, some differences are found in the results. The author thanks I. M. Fuks and A. A. Puzenko for discussion and helpful comments. References 14: 6 Russian, 8 Western.

02415/09599

Buildup and Saturation of Artificial Ionospheric Turbulence Induced by Perturbing Radiation From High-Power Transmitter

18600035b Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 6, Jun 87 (manuscript received 4 Sep 85) pp 702-710

[Article by I. V. Berezin, G. N. Boyko, V. M. Volkov, V. A. Zyuzin, G. P. Komrakov, A. M. Leonov, A. N. Maresov, V. A. Ryzhov, and V. A. Solynin, Scientific Research Institute of Radiophysics]

[Abstract] Experiments concerning perturbation of the ionospheric plasma by short-wave radiation were performed in the Sura facility during the 1982-83 period (March, April, October), the Sura transmitter system having a power of 150-280 MW in the 4.5-9 MHz frequency band with either ordinary or extraordinary polarization of radio waves and the Sura receiver antenna system being equipped to detect each polarization separately. Pumping waves of two frequencies, 4.785 MHz and 5.828 MHz, were transmitted with ordinary polarization. Probing waves of up to 75 MW power were transmitted in pulses of 0.15-1 ms duration at repetition rates of 25 Hz or 50 Hz, also with ordinary polarization, the absolute frequency difference between probing waves and pumping waves never exceeding 300 kHz. Measurements revealed a wideband anomalous attenuation of probing radio waves in the ionosphere. This attenuation has been found to increase with increasing radiation power, its magnitude and development time eventually stabilizing as a result of saturation of inhomogeneities artificially induced in the ionosphere by the pumping radiation. The findings are based on evaluation of the experimental data, including analysis of the echo signal structure. The authors thank V. V. Vaskov for assistance, A. V. Gurevich for discussion and suggestions, and S. A. Metelev, V. A. Frolov for participation in the control experiment. Figures 6; references 14: 12 Russian, 2 Western.

02415/09599

Electrophysical and Optophysical Properties of Air Ionized by Short Pulse of Fast Electrons

18600035c Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 6, Jun 87 (manuscript received 19 Aug 85) pp 720-728

[Article by Yu. P. Vagin, N. L. Stal, V. D. Khokhlov, and A. A. Chernoyarskiy, All-Union Scientific Research Institute of Optophysical Measurements]

[Abstract] The equation of kinetics describing a nonstationary uniform beam plasma is solved, for the purpose of determining the evolution of electron distribution in air and of luminescence of air following secondary-electron avalanche caused by injection of a short beam of primary 100 keV electrons and accompanied by retardation of the latter. Solving that equation by the method of multigroup approximation rather than by direct numerical integration, which requires not only a large computer capacity but also availability of electron-molecular collision data, facilitates analysis of the transient processes. The results of theoretical calculations on this basis for two luminescence wavelengths (337.1 nm and 391.4 nm) agree, after some refinement, with experimental data on beam plasma dynamics obtained by photoelectric measurements over a wide range of air pressure from 1 torr to far above 40 torr. Figures 5; references 17: 12 Russian, 5 Western.

02415/09599

Effect of Drift of Inhomogeneities of Efficiency of Reversal of Wave Beam by Phase-Conjugation Mirror in Turbulent Medium

18600035d Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 6, Jun 87 (manuscript received 7 Feb 86) pp 761-770

[Article by A. V. Polovinkin, Gorkiy State University]

[Abstract] Reversal of a wave beam by a phase-conjugation mirror in an atmosphere with large-scale turbidity and a wind in the direction of the beam is analyzed for efficiency. As the measure of efficiency serves the projection of the complex amplitude of reflected waves upon return to the plane of the source onto the beam leaving the source, this projection being normalized to the amplitude of waves leaving the source. Analysis and calculations yield the dependence of the reversal efficiency not only on the ratio of beam diameter to mirror diameter but also on the wind velocity and thus the velocity of drifting inhomogeneities. First is considered the condition of a very low drift velocity with the possibility of 100 percent reversal efficiency. Next is considered the condition of high drift velocity. In this case the reversal efficiency is found to decrease as the scattering angle increases, in accordance with an inverse-exponential law, whether the drift velocity is constant or variable along the optical axis. The author thanks A. I. Saichev and A. N. Malakhov for comments. Figures 2; references 13: 12 Russian, 1 Western (in Russian translation).

02415/09599

Modulation Transfer From High-Power Radio-Frequency Radiation to Ionosphere During Their Interaction

18600035e Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 30 No 6, Jun 87 (manuscript received 5 May 86) pp 795-797

[Article by V. A. Zyuzin, Scientific Research Institute of Radiophysics]

[Abstract] Experiments concerning modulation transfer from high-power pumping radio waves to the ionosphere were performed in April 1983 day and night in the

200 MW Sura facility. Pumping waves with either ordinary or extraordinary polarization and with "meander" amplitude modulation at frequencies of 0.1-5 Hz (100 percent modulation at 0.1 Hz) were transmitted with their power varied over the 20-150 MW range. Probing waves with either ordinary or extraordinary polarization were transmitted in pulses of 100 gms duration at a repetition rate of 25 Hz. Circular polarization of transmitter antennas and receiver antennas ensured adequate, at least 40 dB, decoupling of differently polarized waves over the 3.3-9 MHz frequency range. An analysis of the data indicates that modulation transfer occurs not only near the level in the ionosphere at which pumping waves are reflected but also within the region of upper hybrid resonance, where thermal parametric instability as well as resonance instability occur, the frequency dependence of the modulation transfer coefficient correlating very closely with trends in the anomalous attenuation of probing waves. The author thanks N. A. Mityakov and V. L. Frolov for discussion. Figures 3; references 6: 5 Russian, 1 Western.

02415/09599

UDC 621.385.69.01

Theory of Parasitic Oscillation in Gyrotrons at Frequencies Corresponding to Harmonics of Main Mode

18600040a Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 6, Jun 87 (manuscript received 23 Jul 85) pp 1274-1280

[Article by G. S. Nusinovich and A. B. Pavelyev]

[Abstract] A theory of parasitic oscillation at harmonic frequencies in a gyrotron is developed, for an interpretation of experimental data on second-harmonic oscillation with 100 W power in a 100 kW gyrotron and for prediction of such oscillations in other power gyrotrons. The problem is treated in the kinematic approximation, on the basis of an equation describing excitation of parasitic harmonics by a weakly relativistic electron beam bunched in the field of the resonant main mode. Assuming a tubular electron beam and negligible losses in the gyrotron walls, this equation is solved for boundary conditions of cutoff at the entrance section and radiation emission at the exit section. From the solution, which yields the evolution of a harmonic mode, are determined the longitudinal profile and the power of a parasitic harmonic, both depending on the amplitude of the main mode and on the deviation from cyclotron resonance. The amplitude of the main mode in turn depends on the beam current. Calculations for a gyrotron with a Gaussian longitudinal profile of the main mode operating at cyclotron resonance frequency indicate the optimum frequency deviation for maximum efficiency, useful for design purposes. The authors thank M.A. Moiseyev for discussing formation of the problem. Figures 3; references 11: 7 Russian, 4 Western.

02415/06662

UDC 621.385.6.001.15

Method of Large Particles in Microwave Electronics

18600040b Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 6, Jun 87 (manuscript received 26 Jun 85) pp 1289-1297

[Article by I. A. Mankin and B. K. Usherovich]

[Abstract] Solution of problems in microwave electronics by the method of large particles is considered, this method being very effective for computer-aided solution of problems in general electronics such as calculation of integral interaction characteristics and device performance characteristics. Its validity in microwave electronics is carefully examined here, of concern being correct description of the motion of real particles in an electron flux with all kinds of collisions and the range of cluster (large particle) size suitable for use of this method. The lower limit on the characteristic cluster dimension, assuming that the charge of a cluster remains constant during motion and uniformly distributed over the volume, is determined by fluctuations of the number and the distribution of electrons in the clusters. The two fluctuations should remain noncorrelated within one cluster and respectively with those in another cluster. The upper limit on the characteristic cluster dimension is determined by collective (wave) interaction, which becomes appreciable when the wavelength of oscillations in the electron flux is much larger than that the Debye radius. When that wavelength is much smaller than the Debye radius, then individual (kinematic) interaction becomes appreciable. The maximum permissible characteristic cluster dimension is much smaller than the Debye radius but otherwise not dependent on it and can be determined only from the results of numerical experiments on the convergence of high-frequency parameters to limits as the cluster size increases. Figures 1; references 6: Russian.

02415/06662

UDC 621.372.823-408.8

Losses in Corrugated Circular Waveguides for Millimetric Waves

18600040c Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 6, Jun 87 (manuscript received 10 Jan 86) pp 1304-1305

[Article by E. A. Alkhovskiy, A. S. Ilinskiy, and N. K. Tsibizov]

[Abstract] Design and performance analysis supported by experimental studies indicates that a deeply corrugated circular multimode or hybrid-mode metal waveguide is, on account of loss losses, most suitable for

millimetric-wave radar and radio-relay or satellite communication. both dispersion and attenuation characteristics of a typical such copper waveguide for the EH_{11} mode at a nominal operating frequency of 45 GHz are shown to be much better than those of a smooth rectangular copper waveguide. Figures 1 ; references 6: 4 Russian, 2 Western.

02415/06662

UDC 537.877:534.13

Nonsteady Diffraction of Intense Light by Sound

18600040d Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 6, Jun 87 (manuscript received 30 Dec 85) pp 1309 1311

[Article by V. N. Mikhaylov and V. M. Musin]

[Abstract] Interaction of two strong light waves and a sound wave is considered, this interaction being a nonsteady process with nonlinear effects such as amplification of the sound and generation of new sound during mixing of the light waves so that the diffraction efficiency becomes nonlinearly dependent on the light intensity. It is calculated here from the solution to the system of corresponding three coupled wave equations, these equations having been shortened to first-order terms only. Analytical expressions for the amplitudes of waves involved in the process are obtained by solution of these equations in Neumann series in the Heaviside function, for generally unequal intensities of the three interacting waves and for arbitrary light pulse duration but assuming constant power of the pump wave. References: 6 Russian.

02415/06662

UDC 621.396.96.965

Control of Field-of-Vision Configuration in Surveillance Radar

18600040e Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 6, Jun 87 (manuscript received 5 Nov 85) pp 1311-1314

[Article by G. V. Kalin and I. O. Kirichenko]

[Abstract] A radar continuously scanning space along one angular coordinate *o/, as well as that coordinate **o/(t) as a function of time t. This coordinate also determines the direction of maximum-intensity radiation. The optimum control designed so that **o/(t)=t- ı(**o/) ensures constancy of all detection characteristics on a straight segment within a scan sector of finite width Gd**O/. This is demonstrated by the dependence of the ratio of scan time at variable speed to scan time at constant speed (circular field of vision) on that width of the scan sector, which has been calculated for various fixed ratio of radius R_O (circular field of vision) to distance R_B (from point along coordinate **o/ where detection characteristics must be ensured to source of probing signal). With such a control it is possible to shift the field-of-vision circle toward **o/ O with change of scan time or change for radius and to deform it into ellipses with the source of probing signal at the center or at one of the foci. Figures 2 ; references: 2 Russian.

02415/06662

Immunity of Letov-Kalman Optimum Radioelectronic Tracking Systems To Additive Interferences

18600007a Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received 21 Oct 86) pp 3-5

[Article by V. I. Merkulov]

[Abstract] High-precision radioelectronic tracking systems with Letov-Kalman optimum control are analyzed for immunity to additive natural and intentional interference, as optimality criterion being stipulated the probability of such a system functioning within given error limits and as performance criterion being considered loss of information only. The control algorithm is modified accordingly to ensure, however, minimization of the tracking error with a limit on the energy of control signals. References: 6 Russian.

02415/09599

Characteristics of Time Discriminator for Stroboscopic Quantization of Radio Signal

18600007b Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received 3 Aug 86) pp 16-18

[Article by D. V. Nezlin and A. N. Bystrov]

[Abstract] Stroboscopic time quantization of a radio signal in a digital range finder is considered, this method being particularly effective when sufficiently accurate measurement of the quantization frequency and thus an adequately fast response of the time discriminator are required for programming such an instrument with the aid of a microcomputer. Its accuracy characteristics are calculated, assuming first only a noncorrelated noise with given dispersion at the discriminator input and a correspondingly random voltage along with a triangular or rectangular signal envelope at the discriminator output. Amplitude fluctuations are included next, the added error being minimizable by shortening the measurement time but with a larger number of quantization steps. Figures 3; references 5: 3 Russian, 2 Western.

02415/09599

Fluctuation Sensitivity of Radiometer With Controllable Current-Voltage Characteristic

18600007c Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received 22 Oct 86) pp 18-20

[Article by V. A. Ilin, A. A. Naumov, and V. S. Etkin]

[Abstract] Increasing the fluctuation sensitivity of a wideband radiometer by means of a Josephson point junction as nonlinear control device is considered, inasmuch as the current-voltage characteristic of this device will be altered already by a very weak noisy control signal. Sensitivity calculations for such a radiometer and a modulation-type one indicate an at least 2:1 advantage of the former as well as the conditions necessary for maximizing it. Design guidelines are established on the basis of theoretically predictable and experimentally verifiable characteristics of Josephson point junctions. The authors thank Ye. M. Gershenzon for interest and fruitful discussions. References 6: 5 Russian, 1 Western.

02415/09599

Optimization of Digital Feedback

18600007d Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received 20 Nov 86) pp 41-43

[Article by A. P. Lisitskiy and V. V. Nikiforov]

[Abstract] Design optimization of a digital corrective feedback device compensating nonlinear combination-frequency distortions is considered, such a corrector being essentially a recursive filter used typically for linearizing the output signal of amplifiers. In a high-frequency amplifier channel the distorted output signal is fed to it from a directional coupler through an amplitude demodulator, a subtractor, and an analog-to-digital converter, whereupon it feeds the corrected signal to an amplitude modulator on the amplifier input side through a digital-to-analog converter and a low-pass filter. Another directional coupler, before the amplitude modulator on the amplifier input side, sends a part of the input signal through another amplitude demodulator to the subtractor on the amplifier output side. Optimization of the feedback performance characteristics requires only determining the spectral power density of the distortion signal and constructing the appropriate model for search of the optimum, either minimum total power or minimum maximum spectral power density. Only one model is needed here, a huge advantage over repetitive simulation of the transmission of a random signal. Figures 3; references 3: 1 Russian, 2 Western.

02415/09599

Field of Decametric Radio Waves in Dead Zone of First Skip

18600007e Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received, after revision 27 Nov 86) pp 55-60

[Article by Yu. A. Chernov, A. U. Zhiltsov, and A. V. Khevrolin]

[Abstract] Power flux density and field intensity of decametric radio waves in the dead zone of the first skip between a receiver antenna in the form of a short vertical stub and a multitier (2/4, 4/4, 8/4) cophased horizontal wideband transmitter antenna are calculated, for an analysis of electromagnetic compatibility and determining the boundary of that zone. Into account is taken scattering of radio waves in the ionosphere, which is known to occur within that dead zone and found to "fill" its null sites. The field intensity here is found to decrease monotonically with increasing distance beyond an isotropic receiver antenna, the effect of ground being disregarded, but to peak within the dead zone in the case of an even slightly directional one. Figures 6; references: 12 Russian.

02415/09599

Effective Efficiency of Radiometer Antenna

18600007f Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received, after revision 12 Nov 86) pp 68-70

[Article by V. T. Fedin]

[Abstract] The concept of "effective" efficiency in radio astrophysical measurements, namely gross efficiency corrected for scattering, is modified by resolution of the scattering coefficient into components independent of the variable solid angle embracing an observed object and their product. An expression for this efficiency is derived on the basis of the general relation between the temperature of the radiometer antenna, more precisely the integral of its space distribution density, and the apparent (radio brightness) surface temperature of an object. The resulting expression is then simplified by letting the gross efficiency approximately be $gh = Ggv^2_{0.5}/4gp$ (G - ratio of radiation intensity within that solid angle to maximum radiation intensity within the antenna radiation pattern, $gv_{0.5}$ - angular width of major lobe of the antenna radiation pattern). The antenna gain and aperture area utilization factor can then also be readily calculated. The author thanks N. P. Marin and Yu. B. Molochkov for assistance. References: 5 Russian.

02415/09599

Use of 12-Pole Reflectometers in Microwave Measurements

18600007g Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received 10 Oct 86) pp 70-72

[Article by S. M. Nikulin and A. N. Salov]

[Abstract] Measurement of the complex reflection coefficient and the S-matrix parameters of microwave devices with a 12-pole reflectometer is analyzed, such a measurement being preceded by calibration of reference gauges as well as of instrument constants and followed by digital data processing on a microcomputer. The instrument has six arms: four of them receiving signals from absorption-type power transducers, one connected to a generator of harmonic microwave signals through a phase shifter, and one connected across the test object. The relevant relations for a four-pole equivalent network of microwave devices indicate that calibration and measurement on the basis of maximum-likelihood estimates will be most efficient and accurate. Figures 2; references 6: 4 Russian, 2 Western.

02415/09599

Attenuation of Millimetric Waves by Rain

18600007h Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received, after revision 8 Dec 86) pp 73-75

[Article by A. S. Azarov, Yu. S. Babkin, N. F. Buranbayev, A. V. Koldayev, A. F. Mironov, V. V. Stroganov, and Ye. V. Sukhonin]

[Abstract] Attenuation of obliquely propagating millimetric radio waves by rain is evaluated, taking into account and separating the effect of clouds. Calculations are based on the model of a cloud comprising a mixture of fine water droplets and dry ice crystals above the thawing zone, with rain alone below the thawing zone down to ground. Wave attenuation by ice crystals and wave scattering at radio brightness temperatures are ignored, both being negligible, which simplifies the equation of radiation transfer through a cloud-rain system. This equation is solved for vertical probing and application to refinement of weather forecasts on the basis of radar readings. The wave attenuation statistics are found to become less influenced by clouds as the rain intensity increases. Figures 2; references 16: 5 Russian, 11 Western.

02415/09599

Effect of Inhomogeneities on Scattering-Polarization Characteristics of Objects of Simple Shape

18600007i Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 (manuscript received, after revision 29 Oct 86) pp 76-79

[Article by Ye. L. Kazakov, P. N. Litvinenko, Yu. M. Shishkin, and A. I. Kravchenko]

[Abstract] An experimental study of cylindrical radar targets was made, for the purpose of determining the effect of inhomogeneities on their scattering-polarization characteristics. Three aluminum cylinders of equal diameters and lengths were mounted horizontally on a cradle and rotated for measurement of the amplitude elements of their scattering-polarization matrix. One cylinder was plain solid, for reference, one was solid with a hoop of uniform thickness and width embracing it symmetrically in the middle at a 76 degree angle to the axis, and one was hollow with uniform wall and bottom thickness. A comparative evaluation of the results reveals that both a buildup and a cavity widen and smoothen the lobal scattering pattern of axially incident vertically or horizontally polarized electromagnetic waves, owing to strong depolarization of the latter upon reflection. Figures 4; references: 3 Russian.

02415/09599

Unidirectional Antennas With Capacitive Top Load on Pedestal

18600007j Moscow RADIOTEKHNIKA in Russian No 7, Jul 87 pp 82-83

[Article by Yu. A. Korchagin; annotation of article No 1067-sv deposited at Central Scientific and Technical Institute 'Informsvyaz', 9 pp with 4 figures and 5 bibliographical references]

[Abstract] Characteristics of vertical antennas with capacitive top load mounted on pedestals are evaluated, as model serving a good conductor of semispherical shape mounted above ground so that its effective height is equal to its radius. Measurements made on transmitter and receiver antennas within the 15-20 kHz frequency band have revealed a strong dependence of the effective height on the altitude of the load terminals. The effective height was found to be maximum, within the 14-22 m range depending on the direction of wave propagation, with the load stretching from the central pedestal to the second one.

02415/09599

Cylindrical and Image Slot Lines (Review)

18600017a Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 32 No 7, Jul 87 (article received after revision 16 Apr 86) pp 1345-1366

[Article by G.I. Komar and V.P. Shestopalov]

[Abstract] A survey is given of the present situation concerning microwave transmission lines. Centimeter range integrated circuits use strip lines but attempts are now being made to find the optimum solution for mm wave transmission and cylindrical and image slot lines are now considered best. The various types of slot lines are surveyed: planar, waveguide slot, cylindrical slot (mm wave fiber lines) and image lines for mm-range IC. The electrodynamic characteristics of cylindrical and image slot lines and the design principles for image lines are discussed. The fundamental mode of the cylindrical and image lines is the cylindrical slotwave which is the

electromagnetic analog of the Helmholtz acoustic wave which has the characteristics of various types of waves and is a surface wave with different bulk localizations of the E and H fields in the quasistatic case. It is classified as quasi-H_{oo}-mode. The attenuation in cylindrical and image lines is no worse than in cm-range transmission lines. Away from the cutoff wavelength the cylindrical line is characterized by weak dispersion and can transmit video pulses practically without phase distortion. The trapezoidal image line is the most effective for extreme miniaturization and combinations of single and multislot image lines can be used for the design of multi-channel power splitters, mixers, switches and twists. Another modification is an image line plane parallel waveguide for new types of wavemeters, channel frequency dividers and spectrum analyzers. Image line technology can be used for miniaturization of mm-range antenna feeder IC. Figures 9; references 86: 72 Russian, 14 Western.

12497/9738

Pulse-Time Digital-To-Analog Converter

18600050a Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 87 pp 15-16

[Article by Yu. I. Ivanov]

[Abstract] A digital-to-analog converter is described which combines high accuracy with tunability to loads over a wide voltage and current range. A counter forms a sequence of square pulses, their duration being proportional to the numerical value of the code to be converted and their repetition rate being constant. The code appears at one input of a comparator, for comparison with that pulse sequence fed to the other comparator input by the counter. The counter has two inputs, one for repetition-rate pulses and one for clock-frequency pulses, the clock frequency being equal to or higher than the repetition rate multiplied by the number of possible states the counter can be in. Repetition-rate pulses also set an RST trigger into the S state, this trigger being switched into the R state by a voltage drop which forms at the comparator output when the pulse sequence and the code at its respective inputs are equal. An electronic switch passes or blocks current from the trigger to the external circuit. The scheme can be expanded into a multichannel one. The operation of such a decoder is demonstrated on conversion of a code with sign symbol. Figures 2; references 1: Russian.

02415/09599

Absolute Radiometer

18600050b Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 87 pp 23-25

[Article by L. Yu. Ivashkova, A. S. Ilin, M. N. Pavlovich, V. I. Sapritskiy, M. A. Verevivheva, and V. V. Menshikov]

[Abstract] An absolute radiometer of the substitution type has been developed and built, with automatic temperature stabilization, at the All-Union Scientific Research Institute of Optophysical Measurements for energy photometry of noncoherent radiation. The advantages of an absolute radiometer serving as reference radiation receiver over a reference radiator are that it does not require a special black-body model, nor determining the temperature of the device and minimizing the temperature gradient along the cavity at high temperatures. A substitution radiometer compares the thermal effect of optical radiation with that of electric current and does it very accurately as well as nonselectively over the entire recorded spectrum, while the electric equivalent of radiation must be reliably determined. The radiometer must have a maximally linear transfer function and a long-term stability. The receiver is a hollow cone inside a conical shield and behind an aperture stop. The cone, having a 12 mm base diameter and a 15 deg vertex angle, is wound by electrolytical deposition and the aperture stop is produced by photolithography. The cone with shield is surrounded by a coaxial thick hollow copper cone serving as heat sink. The heat sensor is a battery of eight Cu-constantan wire electrodes connected in series, with 30 junctions each. The receiver-radiometer performance and instrument characteristic are theoretically based on the solution to the boundary-value problem for the steady-state temperature field under conditions of radiative and convective heat transfer. The electric equivalent of radiation, defined as the ratio of the respective average-temperature rises, has been calculated with correction for parasitic heat transfer, geometrical imprecision, and presence of air. Its value above 0.99 was verified by certification tests and error analysis of measurements. Figures 2; references 7: all Russian.

02415/09599

Simple Method of Determining Dimensions of Small-Diameter Gaussian Light Beams

18600050c Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 87 p 26

[Article by G. M. Gusakov, A. A. Komarnitskiy, and A. I. Frolov]

[Abstract] An accurate direct method of determining the dimensions of light spots which nanosecond-pulse Gaussian laser beams with small diameters of the order of 0.1 mm and with energy density of 0.1-5.0 J/cm^2 produce on surfaces of materials is outlined, this method taking into account irreversible physical processes. It utilizes the appearance of concentric rings with sharp boundaries on the surface such as that of a semiconductor covered with a thin layer of pure light-absorbing dye. Each successive ring has a different, successively higher, threshold energy and the spot radius does not depend on the total laser pulse energy. The radii of successive rings are measured accordingly at successively higher pulse energy levels, which can be done very accurately, whereupon the spot radius is determined from the linear dependence of the ring radii on the logarithm of the pulse energy. The method was tested experimentally on a YAG:Nd laser with Q-switching, emitting radiation of 530 nm wavelength in pulses of 50 ns duration. The beam was focused by an optical lens having a focal length of 5 cm. The pulse energy was varied stepwise or continuously by means of neutral light filters and Fresnel attenuators. The pulse parameters were measured with an IMO-2N power meter and a high-speed p-i-n silicon photodiode. The results, particularly the readings of threshold pulse energy for formation of rings, have been checked against the threshold pulse energy for surface melting of a Si single crystal and against available data. Figures 1; references 6: 2 Russian, 4 Western (1 in Russian translation).

02415/09599

Measurement of Phase Characteristics of Photodetectors

18600050d Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 87 pp 27-28

[Article by V. A. Vaskov, S. A. Gonchukov, N. V Naumov, V. N. Petrovskiy, and R. A. Shananin]

[Abstract] An experimental study of photodetectors for two-mode lasers with mode splitting was made, its purpose being to determine the dependence of their phase-frequency characteristic and phase shift on their spatial voltage bias. Measurements were made with an FV-06 phase-difference meter: for Ge avalanche photodiodes (LFD-2) at the 630 nm wavelength of an He-Ne laser using also FEU-51 photomultipliers, for InSb cooler photodiodes at the 3,390 nm wavelength of an He-Ne laser, for Cd-Hg-Te photodiodes at the 10,600 nm wavelength of a CO_2-laser. The laser radiation, after polarization, was focused on the sensitive area of a reference photodetector as well as on that of the tested one. The amplitude-frequency characteristic was measured concurrently. The voltages were: V_1 = 1,600 V and V_2 = 1,200 V, V_1 = 1,600 V and V_2 = 1,400 V, $V_1 = V_2$ = 1,400 V, V_1 = 1,200 V and V_2 = 1,400 V. Figures 2; references 9: Russian.

02415/09599

Determination of Photon Radiation and Electron Radiation Doses Absorbed by Medium for Purposes of Radiation Therapy

18600050e Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 87 pp 58-60

[Article by B. A. Berlyand and Yu. I. Bregadze]

[Abstract] Determination of doses of high-energy 0.6-50 MeV photon radiation and 5-50 MeV electron radiation absorbed by a medium is analyzed theoretically from the standpoint of eventual practical application to radiation therapy, water being the most suitable absorbing material in accordance with the 1969 ICRU report. Doses absorbed by a quiescent medium without ionization chamber can be calculated according to the Bragg-Gray relation, or preferably according to its Spencer-Atticks modification, and those absorbed by a medium with such a perturbation according to the R. Loevinger semiempirical relation. In each case it is necessary to measure the mean-spectral stopping power of the material relative to that of air, also the limiting energy and the ion or electron charge per unit air mass in the chamber. Use of the available State primary reference standard of unit absorption dose power in graphite for ionizing photon radiation from a ^{60}Co gamma source is considered, this standard being very precise within the 10^{-3}-10^{1} Gr/s range with 0.4 percent systematic error and 0.2 percent standard deviation. References 11: 4 Russian, 7 Western.

02415/09599

Peaceful Uses of Electrical Engineering in Space

18600010 Moscow ELEKTROTEKHNIKA in Russian No 6, Jun 87 pp 10-16

[Article by USSR Academy of Sciences member N. N. Sheremet'yevskiy]

[Text] In the 30 years since the world's first satellite was launched by the Soviet Union, space engineering has evolved into an independent field of science and engineering and one which is solving a broad range of scientific and technical problems concerning various branches of the national economy. Everyone knows of the Molniya and Raduga satellites, the Meteor weather satellites, the Salyut and Mir orbiting space stations and many others used to study near-earth and outer space, for radio and television broadcasting, weather forecasting and charting courses for ice-breakers.

The work done by academicians S. P. Korolev, M. V. Keldysh, and M. K. Yangel to unite efforts by scientists and specialists in various branches of industry to develop space technology unquestionably played an important role in laying the foundation for the universally acknowledged successes and achievements of Soviet space science and engineering.

The collectives at the scientific research institutes and plants of the electrical equipment industry participate actively in solving the scientific-technical problems of space engineering. The branch has developed many tens of thousands of items for space engineering, including solar batteries, storage batteries, illumination engineering, and cable products, and much more.

Electromechanical engineering plays a substantial role in meeting the demand for space technology. It would be difficult to name a domestic spacecraft or orbiting station in operation or being developed which does not use some electromechanical complexes and devices created in this subbranch. These include actuating devices for systems to orient objects in space and solar batteries for them, precision devices to control the operation of scientific and housekeeping apparatus, and various temperature regulation and life-support system drives. Moreover, since the mid-1960's, electromechanical engineering has successfully developed a separate class of spacecraft, the information devices for meteorology and studying the Earth's natural resources.

The first satellites (ISZ) had no orientation or movement stabilization systems. The most obvious solution to controlling the position of a spacecraft (KA) relative to its center of mass, and the solution predetermined by the increasing complexity of KA functions, was to use jet engines as sources of thrust capable of creating control moments relative to a center of mass. It was using precisely such engines that the first KA position control systems were created. Since systems with jet engines requiring backup reaction mass and a complex on-board storage and distribution system become uneconomical as the service life of the KA increases, it was necessary to create dynamic systems which could control the KA position in space without using reaction mass.

It was accepted electrical engineering practice to use electrical machines as the starting point for building such systems since they could, without changing the moment of the number of KA movements, create control moments relative to a center of mass by changing the rotor speed or relative positioning.

Experience proved that electromechanical orientation systems permit a substantial reduction in the total weight of the KA orientation system, especially during long flights, which has a large economic impact given the high cost of orbiting a unit of mass. Calculations and flight testing showed that the weight of the reaction mass expended over 2-3 months of ISZ flight by an orientation system with jet engines was identical to the weight of an electromechanical orientation system.

In principle, an electromechanical system can be built using either flywheel motors or power gyroscopes (gyrodynes) as the actuating devices. In both instances, the angular velocity of the KA is provided by redistributing the total kinetic moment between the housing of the device and the rotating masses. It should be borne in mind when determining the areas of application of the indicated systems that a change in kinetic moment in the flywheel systems is effected by changing the frequency of rotation of the flywheels, while in the gyroscopic systems it is effected by changing the relative positions of rotors rotating at a constant speed. In addition, in the flywheel systems, the electric power is used mainly to change the frequency of rotation of the flywheels, while in the gyroscopic systems it is used to maintain the frequency of rotation of the rotors. The power consumed by the flywheel-motor or gyroscope control system and the complexity and mass of the orientation system as a whole, including the power supply, increases faster, as the KA moment of inertia increases, when flywheel motors are used, so flywheel system applications are restricted to automatic spacecraft and relatively lightweight orbiting stations. Gyroscopic systems are more appropriate for the heavier orbiting stations and larger space structures.

Electrical engineers have developed several types of actuating devices for KA orientation systems. One of the first was the gyro-power stabilizer developed for the Molniya satellites in the early 1960's.

A gyro-power stabilizer (GSS) (Figure 1) consists of an induction motor with arc stators, a central spindle, and gimbal mount with flexible constraint and gimbal-mounted axis rotation sensors. The squirrel cage of the motor is located on the inner surface of a large flywheel.

The gyro-power stabilizer is used both to stabilize the satellite after its separation from the booster and to control movement about the longitudinal axis.

As the GSS stabilizes the satellite, there is a direct power effect on the housing, attenuating the angular velocities of the satellite and simultaneously transferring kinetic moments along the transverse axes to the longitudinal axis. The active attenuation of the satellite rotation about the longitudinal axis by the jet engines ultimately leads to damping along all three axes. The GSS is also used as a two-component angular velocity sensor, permitting the use of only one angular velocity sensor along the longitudinal axis in the control system. The GSS imparts the gyroscopic properties to the entire apparatus, which considerably simplifies controlling the guidance of the satellite and keeping its longitudinal axis pointed in the needed direction. When controlling movement about the longitudinal axis, the GSS is used as an ordinary flywheel motor.

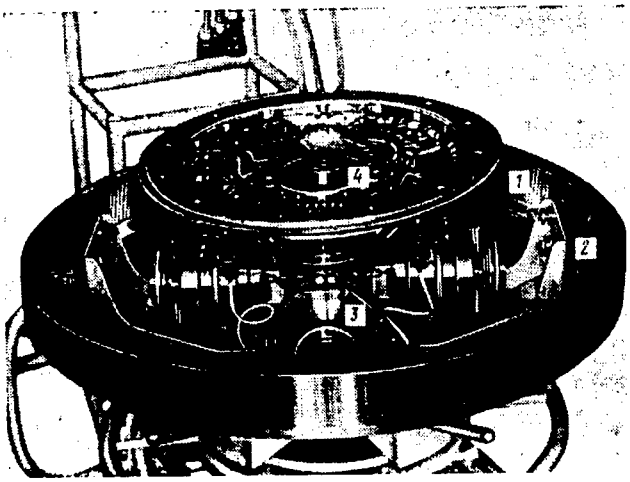


Figure 1. GSS Gyro-Power Stabilizer

Key:
1. Rotor
2. Arc stator
3. Flexible shock absorber
4. Spindle

Basic Parameters of a Gyro-Power Stabilizer

- angular momentum, Hb5 mb5 sec 100
- control moment, Hb5 m.....0.3
- coefficient of viscous constraint, Hb5 mb5 sec ..150
- coefficient of flexible constraint, Hb5 m 2.5
- rotor diameter, m 0.76
- weight, kg.....87

The technical solutions used in the GSS proved to be quite effective and have continued to be valuable right up to today. The fact that the GSS have been used in all generations of the Molniya communications satellites confirms this.

The first electromechanical orientation system used in domestic satellites was developed and began operating in 1964 in the Kosmos series and in the Meteor weather satellites [1]. That system included three flywheel electric motors which used two-phase induction motors with a flywheel weight on the shaft. The shaft axes were oriented in three mutually perpendicular directions. The system provided initial KA stabilization after separation from the booster, orienting and stabilizing it relative to the orbital system of coordinates.

Specifications for the Meteor KA Orientation and Stabilization System

- vertical orientation accuracy, degrees....not at least 2
- course orientation accuracy, degrees...at least 2.5-3.5
- power used, W 50*
- weight, kg 200**
- operating life, years 2
- *About 10 percent of the available KA power.
- **About 15 percent of the weight of the KA.

The KA orientation system being examined should recall the original two-component electromagnetic kinetic-moment discharge system (SSKM) first used domestically in the Meteor spacecraft [3]. Interacting with the Earth's magnetic field, that system discharges the initial kinetic moment (KA stabilization) and compensates for the constant component of the external perturbation moments acting on spacecraft in near-earth orbital flight. The SSKM enables one to eliminate the gas-jet system, saving about 50 kg in orientation system weight.

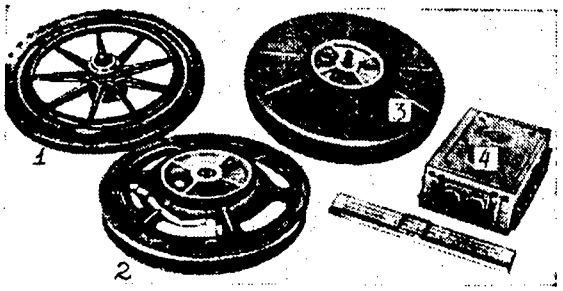
Basic SSKM Parameter

- moment developed by each of the two electromagnets, Ab5 m^2.....500
- weight, kg.....16
- average power consumption, W:
  —in stabilization mode.....40
  —when compensating for the constant component of external moments.....3

The next development in electromechanical orientation systems was the Meteor-3 KA orientation system.

A spatially positioned orientation and stabilization system with a pitch and roll error not exceeding 10', a yaw error not exceeding 20' and an angular velocity error not exceeding 0.0005 degrees/sec was required of these devices to meet the high demands for accuracy and geographic linkage of the information obtained.

In the course of developing this orientation system, many scientific-technical problems were solved and many circuitry engineering and design solutions were found which met those demands. One critical difference was the use of contactless d.c. flywheel electric motor [3]. These motors (Figure 2) have a nonmagnetic armature whose windings are in the slack of the magnetic system, eliminating armature cross-magnetization losses, relieving bearings of magnetic tractive forces and eliminating toothed magnetic grippers. Another advantage of this design is that all the active materials of the magnetic conductor are used as the flywheel mass of the rotor.



Key:
1. Flywheel rotor
2. Stator
3. Housing
4. Control unit

The maximum kinetic moment developed by the flywheel motor is 20 Hb5 mb5 sec and the maximum control moment is 0.35 Hb5 m; the motor weighs 10.5 kg.

A different kind of flywheel motor control is used in this orientation system. It is linearly continuous, while relay control was used in the Meteor KA orientation system. A gyroscopic course sensor based on an altitude gyroscope using local-vertical plotter and solar-sensor signal-based isodromic correction was used to increase course orientation accuracy.

The development of a cylindrical flywheel motor with electromagnetic rotor suspension (ShDM) in the early 1970's opened up a fundamentally new field of flywheel orientation systems development. The ShDM was intended for use in the active triaxial orientation and stabilization system for the Salyut orbiting stations [4, 5].

The cylindrical flywheel motor (Figure 3) acts as an induction motor. The flywheel motor, in the shape of a hollow sphere, is restrained inside the housing by six electromagnets. It is automatically centered by regulating the electromagnet current using signals from six induction sensors. The rotor turns in a field of six arc stators situated in three pairs in three mutually perpendicular planes on the housing. The speed of the rotor about the three axes is measured by three tachogenerators whose arc stators are situated on the housing similarly to the stators of the electric motor.

In contrast to single-axis flywheels, there are no gyroscopic moments in the cylindrical flywheel motor during spatial rotation of the station, which makes building a high-precision orientation system considerably easier.

Basic Parameters of a Cylindrical Flywheel Motor

- maximum angular momentum, Hb5 mb5 sec.....200
- control moment, Hb5 m.....3
- rotor diameter, m.....0.64
- weight, kg.....230
- speed of rotation, rpm.....800

A circular flywheel with an induction motor friction drive was developed to turn both the station and the cylindrical flywheel motor about the longitudinal axis (Figure 4).

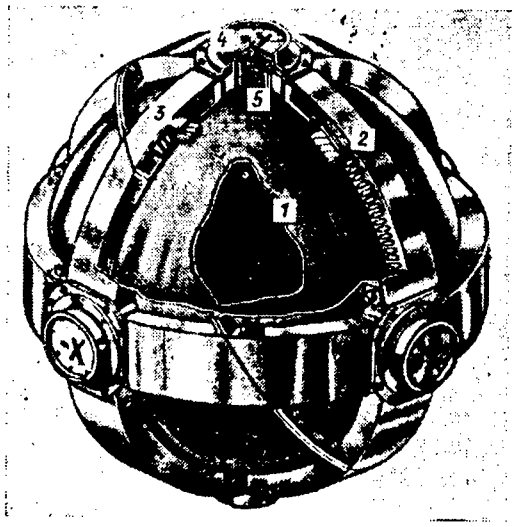


Figure 3. Cylindrical Flywheel Motor

Key:
1. Rotor
2. Stator arc
3. Tachogenerator
4. Electromagnet
5. Position sensor

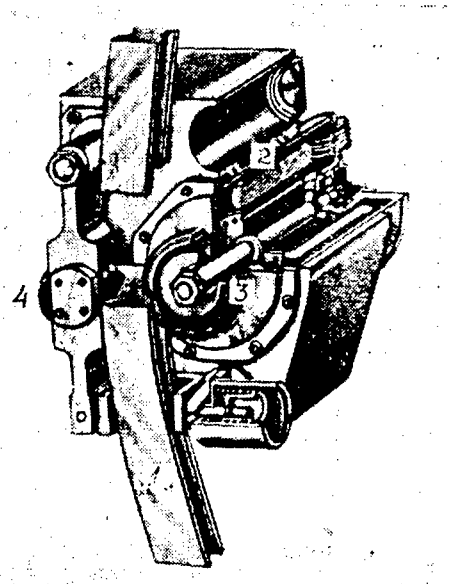


Figure 4. Support Subassembly of a Circular Flywheel Motor

Key:
1. Flywheel ring
2. Drive motor
3. Drive roller
4. Clamp roller

Basic Parameters of a Circular Flywheel Motor

- maximum angular momentum, Hb5 mb5 sec..1,000
- control moment, Hb5 m.....200
- rotor diameter, m.....2.7
- weight, kg.....140
- frequency of rotation, rpm.....80

Many of the concepts and solutions found in the cylindrical flywheel motor with electromagnetic rotor suspension are now basic and have been further developed in the two-stage power gyrodyne gyroscopes with electromagnetic bearings [6-9].

The pivotal problem of ensuring long operating life for a rotor turning at high speeds was solved by using electromagnetic bearings (Figure 5). A geared precession electric drive tracking at a speed assigned by the BTsVM [on-board digital computer] was used to pair high gyromoments with smooth change in the control moment in the gyrodyne.

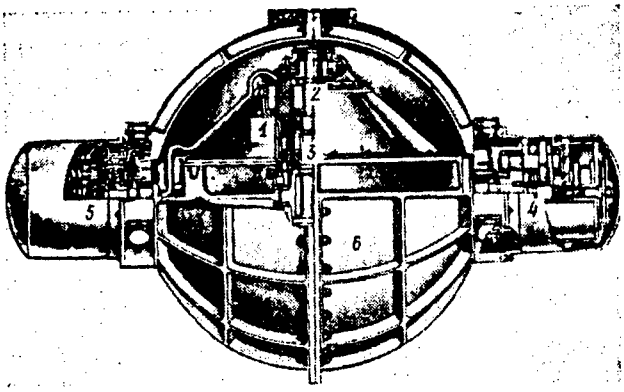


Figure 5. Two-Stage Power Gyrodyne Gyroscope

Key:
1. Rotor
2. Electromagnetic bearing
3. Rotor electric drive
4. Precession drive
5. Contact conductor
6. Housing

The gyrodyne uses a frequency-controllable induction drive to maintain a stable speed of rotation of the massive rotor and its rapid deceleration with minimal power consumption. A special circular contact conductor provides the electrical link between the power supply and gyrodyne control and the gyroscope itself as the latter is rotating.

The complex problem of stabilizing a flexible, rapidly rotating gyrorotor using inertial nonlinear actuating organs in the form of high-load electromagnets with low power consumption was solved with the development of the gyrodyne.

Basic Gyrodyne Parameters

- angular momentum, Hb5 mb5 sec.....1,000
- control moment, Hb5 m.....200
- angle of precession.....unlimited
- speed of rotor, rpm.....10,000
- rotor diameter, m.....0.4
- gyrodyne weight, kg.....160

This solution opened up prospects for the extensive use of magnetic suspensions, not only in the power gyroscopes of orientation systems for orbiting stations and complexes, but also in electrical machinery transformers, turbomolecular pumps, ultracentrifuges, high-speed precision machine tools, and so forth.

Photoconverted solar energy is the main source of KA electric power. We know that the photoconverter is most efficient when the sun's rays are at a solid angle of up to 15 sr relative to the surface line of the elements. With solar batteries rigidly secured to the housing, the position of the batteries will not always be optimal with regard to the direction of the sun with regard to spacecraft oriented relative to the Earth and to the direction of flight. Under these conditions, devices ensuring that the solar batteries will "track" the sun at any KA attitude in space are necessary to ensure the effective operation of the solar batteries.

The creation of a system for orienting the solar batteries is a complex task when you consider that the rotation of the structural elements of the system must occur in space, where a change in the position of the solar batteries must not disturb the orientation of the apparatus and where the electric power must be transmitted to an air-tight device housing. Solving these problems with respect to the solar batteries orientation system of the Meteor KA's required the development of methods of optimizing the kinematics of the solar batteries and automatic compensation for the reactive torques arising during their rotation, as well as the creation of an anti-friction material designed for use in space.

The electromechanical portion of the Meteor space apparatus solar battery orientation system includes a two-phase induction drive motor and shaft-mounted flywheel to compensate for the reactive torque arising when the solar batteries are turned and a multistep reduction gear and magnetic clutch used to transfer the rotation through an air-tight barrier to the axis of the solar batteries.

The solar batteries are oriented using solar information sensors by rotating them relative to the azimuth-oriented apparatus axis. The battery position control system is a relay type with a low coefficient of rotation (gk_B approximately equal to 0.3). The angle of rotation of the solar battery panels is plus or minus 180 degrees relative to a neutral position. The solar battery use coefficient in orbits of 800 plus or minus 100 km is at least 0.8.

The first autonomous solar battery orientation system was used on the Meteor KA and permitted using solar batteries 2.5 times smaller than in the variant with unoriented batteries, given exactly the same size of power supply, and the weight of the KA as a whole was reduced by 10 percent.

In subsequent KA solar battery orientation systems versions, the electromechanical drive was significantly upgraded because of more-stringent requirements of permissible levels of perturbation moments. In one variant, a contactless d.c. motor with a shaft-mounted compensation flywheel was used as the drive motor in this upgraded drive. The kinematic transmission chain included cylindrical and wave reduction gears. Use of the wave reduction gear permitted substantial improvement in rigidity and reduced backlash and kinematic transfer error. The air-tight wave transfer ensures operation of all high-speed elements of the kinematic chain at normal atmospheric pressure.

A split-taper friction safety clutch was used to protect the kinematic chain from destruction during malfunctions.

The solar battery and the KA power supply were linked by a specially-designed cable drum in which flexible cables were replaced by a sheet of soft conductors.

Along with the previously mentioned electromechanical complexes for orienting and turning the station, electrical engineers also created a complex for orienting solar batteries so as to ensure continuous autonomous orientation towards the sun of each of three panels of solar batteries for the manned Salyut orbiting stations.

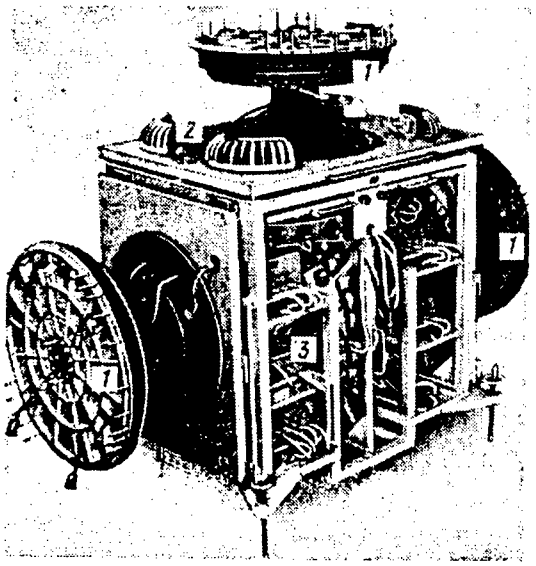


Figure 6. Electromechanical Complex for Orienting Solar Batteries on the Salyut Orbiting Station

Key:
1. Electromechanical Drive
2. Solar sensor
3. Electronic control and power supply apparatus

The complex (Figure 6) consists of three electromechanical drives, each of which includes a high-speed asynchronous motor, reducing gear, magnetic clutch, cable drum and communications cables, 16 solar sensors situated on the station housing, and also a logic device and three control and power-supply units.

Creation of the complex required solving complex scientific-technical and engineering problems associated with developing small, reliable electric motors, a simple, reliable two-coordinate sun-position sensor with full circular view and not requiring a coordinates convertor, reliable electronics, and also control logic optimization.

Basic Parameters of the Complex

- angle of solar battery panel rotation, degrees ..... plus or minus 170
- maximum moment transmitted to the solar battery panels through the air-tight barrier, Hb5 m 80
- angular velocity of turn of the solar battery panel, degrees/sec 0.5-1
- sun search time when emerging from the Earth's shadow or when switching on the complex, min ..... at least 12
- average power consumption, W 80
- weight of complex, kg 240

The first spacecraft, developed by the electrical equipment industry under the leadership of Armenian SSR Academy of Sciences member A. G. Iosifyan and launched into near-earth orbit in 1963 (Kosmos-14), was a so-called electrical engineering space laboratory (KEL) designed to study KA power-supply and orientation control under actual conditions. The KEL had an air-tight housing, two solar batteries and a three-axis flywheel orientation system with Earth and Sun direction sensors. It should be stressed that the KEL was the world's first KA with an electromechanical orientation system. The experienced gained in developing and flight-testing the KEL was one of the decisive prerequisites to the decision by electrical engineers to take on the development of space information devices to study the Earth and near-earth space.

Experimental launches of the first Meteor-type space meteorological information device developed by the electrical equipment industry were made in 1964-1966. The branches of the national economy were regularly provided with weather data by the Meteor-1 meteorological system beginning in 1967, when it began operating [10]. The state Meteor-2 meteorological space system, which is still in use, was accepted for full-time exploitation in 1981.

The information apparatus of the first weather satellites was comparatively simple, and the range of problems they solved was rather narrow. But as KA's improved and the available power increased, as the mix of devices and their spectral bans was broadened, as the accuracy

parameters of the information-measuring apparatus improved, there was a switch from qualitative to quantitative methods of weather forecasting. Thus, whereas only fragmented television images of cloud, ice and snow cover were received for the illuminated side of the Earth initially, it is possible today to receive regular images of the entire Earth several times a day. We have moved from a purely qualitative evaluation of cloud cover based on phototelevision images to a quantitative evaluation of temperature, humidity, and cloud height, microstructure and speed of travel, from integral research on the Earth's radiation balance and the field of radiation of the planet as a whole, to research on the Earth's radiation in narrow spectral intervals and to obtaining as a result of these data information on the vertical distribution of temperature in the atmosphere, its composition, and so forth. Comparative descriptions of the Meteor and Meteor-2 weather space systems are given in Table 1.

Table 1.

characteristics	Meteor	Meteor-2
number of satellites in system	1-2	2-3
Earth's surface covered in 24 hours	20%	all, twice every day
compilation of global maps w/nephanalysis	no	twice every day, once for northern hemisphere, once for southern
compilation of temperature-field maps	no	twice every day
monitoring the radiation situation	no	globally, twice a day and operationally, as necessary
direct transmission of TV information in real time	no	yes
spacecraft:		
height of orbit, km	950	950
inclination, degrees	81-82	81-82
orientation accuracy, degrees	± 3.5	$+1.5$
stabilization accuracy, deg/sec	0.05	0.01—0.02
scientific apparatus:		
television:		
capture bandwidth, km	1,600	2,500
resolution, km	2	1
television (direct transmission mode):		
bandwidth, km	--	2,100
resolution, km	--	1.6×2.8
infrared:		
capture bandwidth, km	1,600	2,600
resolution, km	20×20	8×8
spectrometric:		
capture bandwidth, km		1,200
resolution, km		33×33
spectral band		10 channels in the 10-18μm band
radiometric		measurement of the flux of protons, neutrons and electrons with energies of 0.15—90 MeV

The methods for developing space information apparatus adopted by electrical engineers at the very beginning anticipate dividing the components of the apparatus into two interconnected parts:

the payload platform, which satisfies practically any package of scientific and information systems in terms of accuracy, power, and reliability characteristics;

the instrumentation compartment, which can be modified to accommodate the package of instruments and devices for communicating with the Earth.

Though complex, this approach is justified by the fact that it offers an opportunity to continuously improve KA technical-exploitational indicators through the use of continuously and rapidly improving scientific apparatus without changing the platform. As concerns the platform itself, given a correctly chosen development strategy, it becomes obsolescent more slowly than does the scientific apparatus.

The noted feature of the KA developed by the electrical equipment industry permits using them not only for meteorology, but also for other purposes, such as studying the Earth's natural resources.

The USSR has now developed and is currently operating an experimental operational Earth's resources research space system (IPRZ) based on the Meteor type of KA. It is being used to obtain information to adjust predictions about possible petroleum- and oil-bearing regions, mapping the boundaries of river floodplains, the ice in reservoirs, snow cover ranges, resolving agriculture-related weather tasks (adjusting knowledge about snowfall, availability of moisture), evaluating the seasonal development of agricultural crops and the progress of agricultural work, and much more [11, 12].

It should be noted that, whereas the IPRZ space system is close to being a weather system in terms of its "form" and in terms of the end result—obtaining images of the Earth's surface and environmental data, spacecraft, and information devices with substantially better specifications than those used for meteorology are required to meet the demands made on it.

Table 2 gives several characteristics of an experimental IPRZ system based on the Meteor-2 KA, as well as the requirements made of the spacecraft and information devices in the IPRZ system. It should be borne in mind in this regard that the indicated requirements were established as the maximum permissible given the present state of the technology. It is evident even from this brief summary, which lays no claim whatsoever to completeness, that the problems arising when creating KA for IPRZ systems are very complex.

Due to the accuracy requirements of KA for an IPRZ system, the high-resolution scanner drive instability must not exceed a few angular seconds (thousands of a percent of the angle of turn). It turned out to be possible to meet this demand in the MSU-V high-resolution multispectral scanner electromechanical drive (Figure 7) only by using an interferometric shift measurement circuit [13, 14]. The angular resolving power of the MSU-V drive (at a distance of 80 mm from the center of rotation of the moving part to a reflecting triple-prism) is 0.2" for a plus or minus 4.5 angle of turn.

Table 2

characteristics	experimental IPRZ system based on the Meteor-2 KA	demands on the KA of the IPRZ system
orbit	circumpolar	solar-synchronous
eccentricity (permissible)	0.007	0.0013
KA orientation accuracy, degrees	1—1.5	0.1 or better
angular stabilization speed, deg/sec	0.01—0.02	0.005
geographic surveying accuracy, km	30—50	1—3
number of spectral channels in which images are received simultaneously	1—4	8—11
resolving power:		
in the visible spectrum, km	0.8—0.25	0.15—0.05
in the infrared spectrum, km	--	0.6
radio line information capacity, Mbit	1	8—16
energy flux measurement accuracy requirements, in %	5—10	1—3

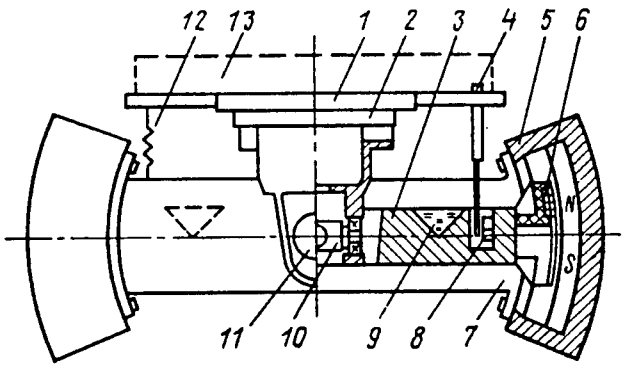


Figure 7. Precision Electric Drive With Interferometric Shift Measurement

Key:
1. Baseplate
2. Foundation
3. Actuating subassembly
4. Sensing element
5. Motor magnetic system
6. Propulsion device coil
7. Frame
8. Indication field shaper
9. Triple-prism
10. Suspension gimbals
11. Single-axle support
12. Centering device
13. Interferometer

The MSU-V drive (Figure 7) is a digital-control tracking drive consisting of an immovable baseplate on which an interferometer is mounted. Secured to it are a foundation and the movable portion, which is connected to the foundation through a gimbal suspension and to which the coils of and electromagnetic propulsion device and the reflecting triple-prisms included in the interferometer optical circuitry are fastened. The propulsion unit magnetic system is connected to the baseplate through a centering device which ensures a controlled, flexible connection. The program for shifting the movable portion is shaped by a program in the form of a certain sequence of pulses, and the actual displacement is monitored using an interferometer with optical-electronic transformers which convert the variable emission of the interfering beams into modulated electrical feedback signals. The program and feedback pulses are recorded by a computer which determines the disagreement between the basic parameter and its derivative and which produces a correction factor which is realized by means of an electromagnetic propulsion unit.

Increasing the reliability of on-board system and KA's as a whole is closely connected with developing effective methods of monitoring their technical status during manufacture and when preparing for launch. The first manual and semiautomatic systems used did not ensure reliable monitoring of complex KA's, so automated testing systems based on control computer complexes were then developed.

The first domestic automated testing system, designed for testing KA's at the manufacturing plant and at the client's control site, was an AIST system developed by electrical engineers. It is an automated, real-time testing system. In the AIST system, the automated testing process is a sequence of interconnected cyclograms of individual operations and includes:

—sending calibrated test signals and control stimuli generated by the control computer or special stimulators to the device being checked;

—receiving verification information from the device being checked concerning its response to the test signals;

—processing the monitoring information according to preset tolerance monitoring algorithms;

—displaying the operational test data and the status of the testing equipment;

—printing out the test results.

The AIST system uses a "man-machine" dialog mode which makes it possible for the operator to interact with the testing system and to obtain needed information from the system on request or, in strictly delimited situations, to intervene.

Use of the AIST system permits:

—improved test and data processing accuracy and reliability by eliminating subjective human errors;

—a more intensive and more complete check of the KA devices over a preset time period, since the control computer possesses an immeasurably greater speed of data processing than a person;

—accelerated testing by combining checks of several KA devices and systems;

—performing various safety procedures faster when unplanned or emergency situations arise during the tests.

In comprehensive testing, the system sends several thousand control and stimulus signals of 30 different types to the KA being checked and processes monitoring information from more than 700 on-board system status sensors (unitized telemetric sensors, commutation apparatus status sensors, analog sensors).

A new generation of testing systems is currently being developed for the Meteor-3 KA. This generation of testing systems is a two-level structure in which the lower level uses a V7 microdevice based on a set of series-K580 BIS [VLIS] and the upper uses V9 control microcomputers. This testing package has improved speed of operation and more stimuli and verification parameters, reaching into the thousands.

The work done by electrical engineers to develop hardware components for orientation and power systems, automated systems, meteorology and resources-study KA's, has naturally not been limited just to the above.

By successfully solving the problems set them by space equipment, electrical engineers have made an important contribution to the peaceful use of space for the benefit of the Soviet people and all mankind.

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UDC 681.785.552:778.38

Effect of Discrete Transcription of Interference Field on Resolving Power of Hologram Diffraction Gratings

18600022a Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 27 Oct 87) pp 4-6

[Article by M. P. Kit and A. F. Skochilov]

[Abstract] Sequential recording (SR) by discrete scanning of the interference field is now increasingly being used in holographic optical systems. The advantage over conventional simultaneous transcription is that it eliminates the dependence of the holographic optical elements on the radiation source power, improves the homogeneity of the diffraction effectiveness of the restored wave front and reduces laser radiation losses. However, discrete transcription of the interference field produces a change in the spectrum of the space frequencies and thus of the resolving power. The study considers the effect of the discrete scanning step and of the parameters of the gaussian interference beams on the resolving power of hologram diffraction gratings produced by SR. SR produces a widening of the space frequency spectrum in the direction of the scanning and is less for scanning perpendicular to the interference bands than for that parallel to the bands. SR produces less broadening of the angular spectrum in comparison with simultaneous recording if the gaussian beam radii are not too great. The widening of the angular spectrum for discrete scanning is determined by the ratio of the scanning step to the gaussian beam radius. Figure 1; references 5: 2 Russian, 1 E. Ger., 2 Western.

12497/06662

UDC 666.1;621.375.9:535

Measurement of Thermal Strength of Laser Active Elements Made of Neodymium Glass

18600022b Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 23 Aug 86) pp 6-8

[Article by V.A. Buchenkov, A.I. Stepanov, M.N. Tolstoy and V.V. Shashkin]

[Abstract] Thermal strength is an important characteristic of laser solid-state active elements and consists of the capacity to resist breakage when subjected to optical pumping. Two methods involving measuring either the pumping power or the temperature drop necessary for producing breakage are used for evaluating laser neodymium glass thermal strength. The pumping power method produces an evaluation which can be used directly in practice though subject to known conditions related to the pumping apparatus. The temperature drop method involves placing a heated sample in cold water and is simple and practical. However, discrepancies were observed between the results of the two methods and further information is necessary concerning the conditions determining the temperature drop method. The paper concerns an analysis by numerical computations of stress conditions in samples of neodymium glass (types GLS1 and GLS22) with different thermal strength factors for abrupt variations in the heat exchange coefficients on the sample surfaces. It was found that the method has limitations determined by the thermophysical characteristics of the samples, sample dimensions and surface cooling conditions. The thermal strength values obtained were found to be unjustified because of the differences in time and in stress action for the measurement method as compared with real laser conditions. However, the method is still useful for studying the effect of certain specific glass characteristics (dimensions or constant thermophysical characteristics). Figures 2; references: 9 Russian.

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UDC 535.317

Coherent Optical Spectrum Analyzer of Low-Frequency Electric Signals

18600022c Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 23 Oct 87) pp 23-24

[Article by A. I. Plakhotnik]

[Abstract] Real-time signal processing is now carried out by coherent optical spectrum analyzers with acoustooptic interaction but the limited aperture and high acoustic wave speeds do not allow processing of low-frequency signals. A new possibility for low-frequency processing is spectrum analyzers with internal optical reversible memories. A basic circuit for an analyzer of this type is described and experimental data on the operation of a unit is given. The input signal passes through an electrooptic modulator. An acoustooptic deflector transforms the time signal into a space signal which passes to a PRIZ space-time light modulator which is the internal reversible memory which forms a spatial light pattern. The transcribed information is read by coherent laser radiation and a spectrum is formed. The frequency range of the analyzer is 10 Hz to 5 kHz and the relative error is 1 percent. The dynamic range of the analyzer is determined by the range of the PRIZ modulator and use of a deflector with greater beam resolution, a larger aperture for the PRIZ modulator and a more powerful coherent light source can raise the analyzer processing range to 210 kHz although substantial nonlinearity is introduced in the output. It is possible to add to the analyzer a second space coordinate (by means of a second deflector) so as to realize a convolute spectrum with a signal processing range up to 50^5 Hz and an error of 10^{-4}. If the second coordinate is added by means of a set of electrooptic modulators, a new type of analyzer is produced which can process arrays of signal data. Figures 2; references: 5 Russian.

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UDC 681.775.2:621.383.52

DKD-2 Two-Channel Projection Device for Visible Spectrum Range

18600022d Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 23 Aug 87) pp 26-29

[Article by V. f. Zakharenkov, N. V. Lazbekina, G. I. Larkova, V. Xh. Ploshkin and T. M. Tsykunova]

[Abstract] The DKD-2 is an improved projector for the measurement of visible spectral range parameters of photodetectors such as resolving power, light sensitivity and contrast sensitivity and is used for certification with reference to state standards. In comparison with previous projectors, it has better resolution and a broad spectral range with a large imagery field and good precision for measurement of the illumination level of imagery. By using an additional set of narrow-band filters it is possible to measure the spectral characteristics of photodetectors. The spectral range of the projector if .46-1.1 micrometers. The projector consists of a main channel for the projection of test tables, a background channel and two auxiliary channels—one for high levels of illumination (10 000 lux) and one for calibration. Maximum resolution is obtained in the main channel. The imagery planes and imagery centers of the optical channels coincide. The optical circuit of each channel consists of illumination source and projection systems. A diagram of the optical circuit is shown and the channels are described. A specially developed photoelectric device consisting of a FD24K silicon photodiode is used for measurement of the illumination of imagery. Figures 3; references 7: 6 Russian, 1 Western.

12497/06662

UDC 535.51

Electromechanical Light Polarization Modulator

18600022e Moscow OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 6, Jun 87 (manuscript received 10 Nov 86) pp 36-37

[Abstract] A. I. Penkovskiy, D. d. Khamelin, R. T. Afanasenko and I. F. Munasipov]

[Abstract] Quarter-wave plates with magnetooptic (MM) and electrooptic (EM) modulators are usually used for modulation of the polarization azimuth and phase difference in photoelectric ellipsometers. However, MM are complex and consume excessive power while EM are expensive and difficult to regulate. Sometimes an electromechanical modulator can be used for the polarization but then another modulator is necessary for the phase difference. The optimal solution is a polarization modulation device utilizing a quarter-wave plate swinging in its plane which was previously used in domestic interferometers but specific details as to the design of the devices is not available. A description is given of the design of a simple electromechanical modulator for simultaneous modulation of polarization and phase difference. The design is based on the fact that there is simultaneous variation of polarization and phase difference when deviation of the crystallographic axes of the quarter-wave plate relative to linearly polarized light occurs with small amplitude deviations of the plate. The design was experimentally used in a polarization reflectometer. Figures 2; references: 5 Russian.

12497/06662

UDC 536.6

Acoustic Thermometers

18600037a Moscow IZMERENIYA KONTROL AVTOMATIZATSIYA in Russian No 2, Feb 87 pp 32-39

[Article by T. K. Ismailov, doctor of technical sciences, A. M. Izmaylov, candidate of technical sciences, Z. Sh. Allakhverdova, engineer, and Ye. V. Mitrofanova, engineer]

[Abstract] The underlying principle of acoustic thermometers being the temperature dependence of the acoustic velocity in a material, these devices offer the advantage of covering a wide temperature range without the need for high-temperature measurement at any instant of time so that the entire temperature profile of an inspection object can be monitored. Acoustic thermometers are designed with either direct or indirect contact between the primary transducer and the inspection object, the mechanism of interaction of sound waves and the material through which they propagate being different in each case. Direct-contact thermometers, operating with sound waves of various amplitudes within a definite frequency range, are suitable for materials with a monotonic temperature dependence of the acoustic velocity. Indirect-contact thermometers, with a sensing element on an acoustic base as buffer channel in thermal equilibrium with the inspection object, are suitable for materials not having a monotonic temperature dependence of the acoustic velocity and subject to uncontrollable influencing factors. Thermometers with a solid sensing element in the primary transducer include those based on resonance and interference, originally proposed for nuclear power applications, and those which measure the sound propagation time. Thermometers with a liquid sensing element in the primary transducer and with a piezoelectric transducer include those which measure the sound propagation time, originally proposed for monitoring the coolant such as liquid sodium in a nuclear reactor, and those which measure sound frequency or pulse repetition rate. The temperature dependence of the acoustic velocity in heat-sensitive liquids used for these thermometers, known a priori, is more linear and steeper than that of solid sensor materials. Thermometers with a gaseous sensing element in the primary transducer and with a piezoelectric transducer include those based on resonance but without interference as well as those which measure the sound propagation time and those which measure the sound frequency or pulse repetition rate. Figures 14; references 28; 16 Russian, 12 Western.

02415/06662

UDC 621.38

Silicon Carbide as Material for Solid-State Electronics

18600037b Moscow IZMERENIYA KONTROL AVTOMATIZATSIYA in Russian No 2, Feb 87 pp 53-60

[Article by Yu. A. Vodakov, doctor of physico-mathematical sciences, and A. G. Ostroumov, candidate of technical sciences]

[Abstract] Advantages and difficulties of using SiC as semiconductor material in electron devices of the next generation are examined on the basis of mechanical as well as thermophysical and elecrophysical properties of its most applicable four forms (cubic 3CSiC, rhombic 15RSiC, hexagonal 4HSiC and 6HSiC) in which it is now produced, unlike $A^{III}b^{V}$ materials, only with abundantly available and no scarce ingredients. Devices which are already or will be eventually built with polycrystalline or monocrystalline SiC include not only diodes and transistors, even field-effect transistors, but alto thermometers and extensometers, detectors of nuclear particles (ga-particles, thermal neutrons), light-activated diodes, and light-emitting diodes. The technological problems are that SiC does not melt under pressures below 100 kbar and decomposed incongruently at temperatures about 2800°C and condensation. Doping is also difficult because of the very slow diffusion of impurities (except boron, beryllium, and to some extent aluminum) into SiC so that other methods such as ion implantation have been developed for making high-quality p-n junctions. Special techniques are required for etching SiC, deposition of a SiO_2 film on its surface, and metallization. These techniques are still being refined, the optimum substrate and contact materials yet to be found. Tables 1; references 51; 30 Russian, 21 Western (1 in Russian translation).

02415/06662

UDC 621.38

Industrial Interference and Ensuring Reliable Control of Technological Processes

18600037c Moscow IZMERENIYA KONTROL AVTOMATIZATSIYA in Russian No 2, Feb 87 pp 61-72

[Article by V. V. Nosov, candidate of technical sciences]

[Abstract] The problem of ensuring reliable control of technological processes in the presence of industrial electromagnetic interference is approached in two ways, either assuming that both interference and useful signals enter a discrete technological device along the same channel or assuming existence of parasitic separate channels for the interference. Reliability is defined in terms of failure probability applicable to each interference source - channel(s) - interference receiver model and including all other nonelectrical as well as electrical influencing factors. Interference characteristics are calculated according to the theory of transient processes in the appropriate equivalent circuit for the various interference modes (statics, lightning, pickup). Interference parameters are measured, for which high-quality instruments commercially produced in the USSR as well as in the United States are available. Modern computer-aided controls for technological processes, built with complex electronic components such as microprocessors and with large-scale interference, must meet stringent interference immunity requirements. Helpfully, USSR Standards are

analyzed here and compared with International (IEC) Standards as well as with United States (MIL) Standards and Swedish (SEN) Standards. Figures 4; tables 8; references 58: 37 Russian, 6 International, 15 Western (1 in Russian translation).

02415/06662

Criteria for Evaluation of Cable Fire-Resistance

18600008a Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 87 (manuscript received 20 May 86) pp 11-13

[Article by E. T. Larina, candidate of technical sciences, and O. V. Krekhova, engineer, All-Union Scientific Research, Design and Technological Institute of the Cable Industry]

[Abstract] The conditions under which cables can be considered fire resistant are discussed and operating conditions for power supply and signal transmission cables are analyzed. It is found that International Electrotechnical Commission (IEC) standards are applicable. The results are presented of investigations of prototypes of KVVG 2 x 1.5 fire-resistant design cables, conducted in accordance with the IEC 331 method. The dependent of the leakage current on the time used in the testing process is calculated. Figures 4; references 3: 2 Russian, 1 Western.

06415/09599

Power Sources of Units With Concentrated Power Flows

18600008b Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 87 (manuscript received 20 May 86) pp 36-39

[Article by A. M. Kruchinin, doctor of technical sciences, Ye. V. Dolbilin, candidate of technical sciences, and A. Yu. Chursin, engineer, Moscow Power Engineering Institute]

[Abstract] The volt-ampere characteristic conditions which determine the operation of plasma, electron-plasma, electron beam, and laser units producing concentrated power flows are analyzed. The principal requirements for power sources are presented. Typical circuits for power sources are considered. A diagram is shown for an electron beam unit power source and is discussed (sources are available with power of 50-630 kW). IT-P1 and ITP-2 sources are used for solid-state lasers while KVANT lasers use MIL and MT sources. High-voltage plasma units can use sources with automatic current stabilization but special equipment is necessary to deal with overvoltage in plasmatron units. Figures 4; references: 8 Russian.

06415/09599

Microprocessor Control System for the Traction Electric Drive of an Electric Drive of an Electric Train

18600008c Moscow ELEKTROTEKHNIKA in Russian No 8, Aug 87 (manuscript received 10 Feb 87) pp 48-50

[Article by L. Yu. Veytsman, candidate of technical sciences, T. B. Larina, engineer, and V. N. Naginayev, candidate of technical sciences]

[Abstract] The principal results are described of work with respect to planning the design of a system of information exchange between loading and section microcomputers in a microprocessor control system for the traction electric drive of an electric train. The architecture of a network of train microcontrol computers, data transmission in information exchange, and methods for an increase of the reliable of the data transmission system are considered. Figures 3; references: 3 Russian.

06415/09599

Investigation of the Effect of Longitudinal Shifts of Holographic Filter on the Relative Scale of Correlated Images

18600004a Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 7 Feb 86) pp 3-8

[Article by V. I. Kozik and O. I. Potaturkin, Novosibirsk]

[Abstract] Holographic amplitude correlators require precise positioning of filters longitudinally because the scale of the spatial spectra is determined by the focal length of the Fourier objectives. Holographic intensity correlators (HIC) operating in spatially noncoherent monochromatic light (or in coherent light with subsequent perturbations) are invariant for longitudinal shifts of filters and can be used for the correlation of images of various scales. The article described theoretical and experimental research on the effects of longitudinal shifts of holographic filters, as well as the input transparencies of HIC and the system of recording holograms, on the relative scale of the images being correlated. Figures 3; references 9: 1 Russian, 8 Western.

06415/09599

Multichannel Holographic Intensity Correlator with Quasimonochromatic Cathode-Ray Tube

18600004b Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 21 Mar 86) pp 8-17

[Article by Ye. I. Korzhov, A. N. Oparin, V. V. Polzhayev, and O. I. Potaturkin, Kiev-Novosibirsk]

[Abstract] The performance is considered of a holographic intensity correlator, in which a quasimonochromatic cathode-ray tube is employed as a light source and as a device for introducing processable images from a television channel, and which can be represented as a source of a modulated spherical light wave moving in a plane perpendicular to the correlator axis. With the object of obtaining maximum use of the light flux, the optical train of the correlator is analyzed, as a result of which its optimum parameters are chosen with allowance made for the technical characteristics of the elements. The experimental results concerned with the correlation of real and test images are described and in the latter case is a multichannel variant which can be used for attaining invariance of processing as concerns geometrical transformations (especially foreshortening) of the images.

06415/09599

Angular Interferometer for Laser Scanning Device

18600004c Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 17 Apr 86) pp 18-24

[Article by I. S. Degtyarev, G. A. Lenkova, and A. I. Lokhmatyov, Novosibirsk]

[Abstract] The article describes the special features and the results of employing an angular interferometer with a nonparallel arrangement of the arms, in which the beam splitter block is constructed in the form of a double-refracting prism. The interferometer has a minimum number of optical components and is distinguished by high stability in operation. Because of using a polarized prism for separation of the light beam, the necessity for applying beam splitter coatings is eliminated. The results are presented of the interferometer's use in the composition of a laser image recorder. Figures 5; references 6: 5 Russian, 1 Western.

06415/09599

Recording and Synthesis of Holograms by Orthogonal Transparencies

18600004d Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 12 Jun 85) pp 24-28

[Article by N. I. Dmitriyev, S. G. Kalenkov, and G. I. Solomakho, Moscow]

[Abstract] A method is considered for spectral analysis and holographic recording of wave fields in which the object field is modulated by amplitude-phase transparencies at the plane of the optical system input. The transmissivity of the transparencies corresponds to orthogonal (such as Walsh) functions. For each Walsh-transparency the intensity is measured of the diffracted light at the output. It is shown that the signals from the detector are proportional to the spectrum of the Walsh field. The possibility is considered of synthesizing holograms by means of Walsh amplitude transparencies. It is shown that different kinds of holograms for spectral analysis can be obtained depending upon the response function of the optical system. Figures 1; references: 3 Russian.

06415/09599

Control of Wave-Front of Light Beam in Medium With Relaxing Non-Linearity

18600004e Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 24 Jul 85) pp 29-33

[Article by V. A. Trofimov, Moscow]

[Abstract] On the basis of an approach put forward by A. P. Sukhorukov and V. A. Trifimov (1982), and Yu. N. Karamzin, A. P. Sukhorukov, and V. V. Trofimov

(1984), this article obtains an equation for control of the focusing and tilt of a wave front, reveals the conditions of stability and convergence of a discrete control algorithm, and analyzes the speed of response of the adaptive system with allowance made for relaxation time of nonlinearity and lag of the system. References 10: 9 Russian, 1 Western (in Russian translation).

06415/09599

Multiple-Beam Two-Frequency Optical Interference

18600004f Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 13 Apr 86) pp 34-40

[Article by V. P. Kulesh, Moscow]

[Abstract] The article theoretically considers the possibility of photoheterodyne conversion of an optical signal into an electrical radio frequency signal by multibeam optical interference. The calculated characteristics of the signals received are derived, and recommendations are made with respect to a choice of the operating conditions for a multiple-beam photoheterodyne interferometer, a block diagram of which is considered. Figures 5; references 6: 5 Russian, 1 Western.

06415/09599

Acoustooptic Mode Snychronizer With Increased Thermal Stability

18600004g Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 23 Mar 86) pp 40-43

[Article by Ye. G. Daurkin, V. I. Semenov, and D. V. Sheloput, Novosibirsk]

[Abstract] A method is proposed for increasing the thermostabilization of an acoustooptic mode synchronizer (AOMS). For this purpose material with a low temperature coefficient of frequency must be used for the acoustooptic lines. The results are presented of an experimental investigation of suitable industrial glasses (to replace the fused quartz now used). The characteristics of LK-3, BK-10, TK-12, TF-3 glasses and fused quartz are compared and it is concluded that glasses with good optical and acoustic characteristics are available which can be used in AOMS. Figures 1; references 8: 5 Russian, 3 Western.

06415/09599

Multifrequency Acoustooptic Interaction in Anisotropic Medium

18600004h Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 20 Jul 85) pp 43-52

[Article by A. V. Trubetskoy, Novosibirsk]

[Abstract] A system of differential equations is obtained which describes Bragg multifrequency light diffraction in an anisotropic medium. On the basis of an approximate solution of a system for a large number of frequencies, expressions are found for the intensities of the signals and noise of scattered light beams. Computations are made of the diffraction parameters: diffraction effectiveness, cross-modulation, ratio of signal-intermodulation background which makes it possible to select optimum characteristics for the mode of operation of the acoustooptic deflectors-modulators of light (AODML). An estimate is made of the diffraction parameters for the case of AODML based on a TeO_2 crystal. The author thanks P. Ye. Tverdokhleva and A. P. Yakimovich. Figures 5; references 10: 6 Russian, 4 Western.

06415/09599

Angular Aperture of Tunable Acoustooptic Filter

18600004i Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 8 Jul 85) pp 52-57

[Article by I. B. Belikov, V. B. Voloshinov, Ye. A. Nikanorova, and V. N. Parygin, Moscow]

[Abstract] The theoretical and experimental results are presented on an investigation of acoustooptic filtrations of light beams. The characteristics are computed and measured of a noncollinear wide-aperture filter based on a TeO_2 crystal in an acoustooptic plane, and in an orthogonal plane. Good agreement was found of the experimental and theoretical results and it was found that the filter can be used for spectral filtration of optical images with good spatial resolutions. The authors thank L. N. Magdish for making an acoustooptic filter available. Figures 5; references 6: 5 Russian, 1 Western.

06415/09599

Limiting Parameters of Acoustooptic Deflectors Based on Paratellurite

18600004k Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 87 (manuscript received 4 Apr 86) pp 58-60

[Article by S. V. Bogdanov and T. A. Bolsheva, Novosibirsk]

[Abstract] In order to supplement data on the low-frequency range based on a procedure considered by the authors in 1985, calculations are made for acoustooptic deflectors (AOD) based on paratellurite (TeO_2), with a

wavelength gl_0 = 0.6328 micrometer and for various medium frequencies (MF) in the 60-375 MHz range. For each value of the MF, the angles ga and gf, which determine the geometrical acoustooptic interaction, the repetition diffraction frequency f_p and the maximum possible band of the frequency gDf_{max}, found from the condition $f_{max} = f_p$, are calculated. It is shown that the frequency limitations of the AOD are caused by attenuation of sound, and not by the occurrence of the frequency of the repetition diffraction in the operating band of the AOD. References 6: 4 Russian.

06415/09599

Noncooled Current Leads for Cryogenic Electrical Engineering Equipment

18600020a Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 87 (manuscript received 24 Sep 86) pp 21-25

[Article by G. I. Abramov and L. I. Rozeyn, candidates of tachical sciences, All-Union Electrical Engineering Institute imeni V. I. Lenin]

[Abstract] Because they are easy to fabricate and have suitable thermal characteristics, noncooled current leads are used for low-temperature experiments with current under 100 A and in heavy-current cryogenic power equipment such as liquid nitrogen cables with a current of 3 kA. The solution of the heat equation for the noncooled lead gives, for a certain current, the variations of the thermal conductivity coefficient and the specific electrical resistance for the conductor used and the temperatures of the environment and the coolant. The study considers optimization of the geometrical dimensions (i.e., the ratio of the length of the lead to its cross-section) corresponding to the minimal heat flow at the cold end. Western publications on the subject are evaluated. Results showed that use of reference data values (published by Oberhauser and Sukhatme 1967) for the thermal conductivity coefficient and specific resistance of the conductor led to errors in calculating heat flows at the cold end and the lead length/cross-section ratio. However correct calculations can be made for copper conductors of various purities if the residual resistance of the conductor is known. Use of reference data published by McFee (1959) can lead to incorrect evaluation of the thermal and geometrical characteristics of leads operating with the rated current load. There is a critical value of the current/rated current ratio at which the lead loses thermal stability. Corrected data for overload conditions are given. Figures 5; references 5: 2 Russian, 3 Western.

12497/09599

Magnetization of Superconducting Topological Generator

18600020b Moscow ELEKTROTEKHNIKA in Russian No 9, Sep 87 (manuscript received 19 Jan 87) pp 42-44

[Article by Yu. F. Antonov, candidate of technical sciences, A. V. Osipyan, engineer, and V. N. Shakhtarin, doctor of technical sciences]

[Abstract] The design of superconducting topological generators (and DC commutator machines) requires computation of the magnetic circuit and the dependence of the flux on the exciter current. At the present time, there is no reliable data on the variations of the magnetic characteristics of ferromagnetic materials at very low temperatures and materials are chosen on the basis of requirements for ordinary machines. Rolled sheet steel is mainly used for the structure while round superconducting enameled niobium-titanium alloy conductors (diameter 0.25-0.33 mm) are used for exciter windings and thin (15-100 gmm) cold-rolled niobium or niobium-titanium alloy for armature windings. Experimental studies were made of the magnetic characteristics of the structural and active materials. Magnetization curves are shown for structural rolled steel used in the TPG-9 topological generator and for thin cold-rolled NB (with 1.5 percent Zr) sheets for armature windings. Six PKhE Hall probes with a range of 86-202 mV/T were used to measure the magnetization of the magnetic circuits of the TPG-9 generator and tests were made with and without the superconducting armature windings. The magnetic field due to the rotation of the serrated ferromagnetic core of the inductor was measured by means of the Hall probes with and without the superconducting windings and the curves are shown. The results showed that the thin-sheet superconducting conductors used for armature windings significantly affected the magnetic circuit parameters of the generator. Screen currents concentrate the main magnetic flux in the entry zone and increase the magnetic induction value. The magnetic resistance to the main magnetic flux across the operating gap increases and additional magnetomotive force is required. This phenomenon must be taken into account in the design of topological generators. Figures 5; references 4: 3 Russian, 1 Western.

12497/09599

UDC 621.382.002

Optical Monitoring of Plasmochemical Etching Processes With Finite Selectivity

18600036a Moscow MIKROELEKTRONIKA in Russian Vol 16 No 5, Sep-Oct 87 (manuscript received 20 Jul 86) pp 397-401

[Article by D. N. Bilenko, V. M. Dolgopolov, T. Yu. Druzhinina, V. P. Polyanskaya, and A. I. Smirnov, Scientific Research Institute of Mechanics and Physics, Saratov State University]

[Abstract] Diffraction methods have been developed for optical monitoring of the etching process, particularly of plasmochemical etching characterized by low selectivity.

Both etching rate and etching depth are determined on the basis of the dependence of the light intensity in the central diffraction peak on the optical properties of the etched material and on the topology of the inspected structure, this relation having been established theoretically with use of Fresnel reflection coefficients. The gist is to simultaneously determine the depth of recess in the chip and the decrement of mask thickness after a given etching time. This can be done by simultaneously measuring the intensity of reflected space-coherent monochromatic light in the central diffraction peak and the intensity of noncoherent light reflected by the chip, which is very effective but requires complex instrumentation. This can also be done simpler by extracting the low-frequency component of the diffraction signal, which oscillates as the etching depth increases and thus as a function of time. Both methods were evaluated experimentally on specimens of Si single crystals with masks consisting of SiO_2 and photoresist. Figures 4; references 15: 8 Russian, 7 Western (2 in Russian translation).

02415/06662

UDC 621.382:8.001.2

Attainable Speed and Electrical Characteristics of Large-Scale-Integrated Digital

18600036b Moscow MIKROELEKTRONIKA in Russian Vol 16 No 5, Sep-Oct 87
(manuscript received 15 Jul 86) pp 436-443

[Article by V. I. Staroselskiy, Moscow Institute of Electronic Engineering]

[Abstract] The speed of large-scale-integrated GaAs devices for digital logic attainable by optimization of their topology and particularly by shortening the gate is estimated on the basis of the two time constants of a field transistor with Schottky gate, these time constants associated respectively with the gate-channel capacitance and the gate edge capacitances depending on the electrophysical properties of such a transistor (electron mobility and concentration, dielectric permittivity, channel flashover voltage) as well as on its topological dimensions. Normally open and normally closed field transistors are considered. Estimates made on the basis of calculations and measurements are extended to LSI direct-access memories. Figures 3; references 20; 3 Russian, 17 Western.

02415/06662

UDC 621.382.8.001.2

Comprehensive Modeling of Elemental Base and Technological Processes for Very-Large-Scale Integration

18600036c Moscow MIKROELEKTRONIKA in Russian Vol 16 No 5, Sep-Oct 87
(manuscript received 26 Sep 86) pp 449-455

[Article by B.V. Batalov, V.A. Kunilov, and I.B. Sayapin]

[Abstract] A software has been developed and written in YaOTIK user's language (Language of Technology and Components Description) for very-large-scale integration on the basis of physical-topological and electrical models. The syntax of this language is simple and comprehensible. The software consists of simulation programs covering all stages of very-large-scale integration, from heat treatment and doping through etching and deposition to pattern transfer by a lithographic process. The database contains data sheets with description of objects and data sheets with specifications, also a dictionary. The software is organized, with a translator and a dispatcher, for analysis and editing as well as display of the results and their storage in an archive. Figures 1 ; references 11; 6 Russian, 1 Polish, 4 Western (1 in Russian translation).

02415/06662

UDC 621.383

Fluctuations of Dark Charge and Background Charge in Charge-Injected-Device Radiation Receivers

18600036d Moscow MIKROELEKTRONIKA in Russian Vol 16 No 5, Sep-Oct 87
(manuscript received 10 Jan 86) pp 463-465

[Article by N. I. Khaliullin, Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] Generation of charge carriers in a charge-injected-device radiation receiver is analyzed, taking into account that the generation rate depends on the already accumulated charge and is not constant as in a Poisson process. From the conditional probability of transition from a state with N charge carriers to a state with N+ 1 charge carriers in the device structure is derived a relation which describes fluctuations of the accumulated charge caused by the shot nature of the generation current. An analysis of this relation indicates that anomalous generation of charge carriers will raise the r.m.s. level of fluctuations of the dark charge and, consequently, narrow down the dynamic range of a photoreceiver. References 4; 1 Russian, 3 Western 2 in Russian translation).

02415/06662

UDC 77.01:53.771.5:778.6

Development of Photographic Material for Recording and Controlling Amplitude and Phase Components of Coherent Wave Field

18600034a Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFFII in Russian Vol 32 No 5, Sep-Oct 87
(manuscript received May 86) pp 366-370

[Article by Yu. S. Andreyev, E. A. Gruz, V. N. Karnaukhov, O. A. Kartasheva, and N. S. Merzlyakov, All-Union State Scientific Research and Planning Institute of Chemistry for Photographic Industry]

[Abstract] Following a review of problems and progress in development of a photographic material suitable for separate recording and then independent control of the amplitude and the phase of a coherent light wavefront, which essentially requires two emulsion layers sensitive to light of sufficiently different wavelengths and the problems re thus chemical as well as optical, results are reported here pertaining to such emulsion layers experimentally produced, evaluated, and optimized. Each layer is an emulsion of silver halide, the lower one on the substrate containing less silver and sensitive to red light and the upper one sensitive to sky blue light. Both have been produced from an emulsion of microcrystalline silver halide, average grain size 0.05 gmm and original concentration 0.29 mol/dm^3. As the concentration of silver halide is decreased by dilution, the degree of contrast first increases to a maximum and then decreases. A gamma within the required gg = 2-4 range is attainable, accordingly, with the silver halide diluted but not below 0.07 mol/dm^3. Various dyes were added to the emulsion with the concentration of silver halide at this lower limit, all of them meeting specifications but Sky Blue 1 (N-octadecyl-3', 5'-dicarboxyanilide of 1-oxynaphthoic acid) being somewhat more effective than Sky Blue 2 and Sky Blue 3. Tables 3; references 10; 5 Russian, 5 Western (1 in Russian translation).

02415/06662

UDC 778.332

Optical Methods of Processing Images on Medical X-Radiograms With Use of Sharp Replica

18600034b Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFFII in Russian Vol 32 No 5, Sep-Oct 87 (manuscript received 10 Dec 85) pp 393-395

[Article by A. L. Kossovoy, Leningrad State Institute of Physicians' Advanced Training]

[Abstract] Optical processing of images on x-radiograms is described, conventional methods having been modified by use of a sharp replica rather than a soft mask so as to ensure adequate evaluation for medical diagnosis. Such a replica can be used for isotropic or anisotropic high-frequency space filtration, with the replica and the original mounted on the same glass plate but on opposite sides of it, as well as for x-radiogram processing by movement of the replica in either or two mutually orthogonal directions relative to the original with the replica alone mounted on a glass plate and two guides provided for that movement. These modifications facilitate optimal detection of details and pathological changes by the necessary differentiation. The apparatus of high-frequency space filtration with a sharp replica was designed with the assistance of an engineer, A. T. Vasilyev. References 5: 3 Russian, 2 Western (both in Russian translation).

02415/06662

Work Underway in Field of Fiber Optics Communications Described

18600082a Moscow ELEKTROSVYAZ in Russian No 3, Mar 88 pp 1-2

[Article under the "Fiber Optic Communications Systems" rubric: "To Our Readers"; first paragraph is epigraph appearing at beginning of article]

[Text] Communications along optical cables, which is becoming increasingly crucial from an economic standpoint, is one of the main directions in scientific-technical progress. Today optical cables and systems have progressed from the experimental research stage and have been introduced into practice. Several fiber optic communications lines [VOLS] with digital transmission systems are being constructed in the USSR—in such cities as Moscow, Gorkiy, Kishinev, Leningrad, Kiev, Minsk, Donetsk, and Tashkent. Long-distance fiber optic communications lines are being installed in the Leningrad-Sosnovyy Bor section.

Optical systems and cables are not only used to derive local and long-distance telephone communications but also cable television, videophone, and radio broadcasting.

The well-known advantages of optical cables—their high carrying capacity, noise immunity, use of source materials that are not in short supply, light weight, small overall dimensions, and nonflammability—have guaranteed them a great future. An intensive process of improving the parameters of both optical cables and optoelectronic equipment is underway. Optical cables with single-mode fibers are undergoing extensive development. Such cables have small dispersion distortions and provide a great transmission distance. The appearance of fluorinated optical fibers with low losses is anticipated.

Work is underway to use the 1.3 and 1.55 μm wavelengths and assimilate the infrared range from 2 to 4 μm, which would make it possible to raise the attenuation value in optical cable to between 0.2 and 0.5 dB and increase the regeneration section length to between 50 and 100 μm. This in turn opens broad possibilities of using optical cables for further long-distance communications because it eliminates the need for the remote electrical power supply of line regenerators and simplifies the cable (copper conductors for DP [not further identified] become unnecessary).

The development of optoelectronic devices intended for transmitting and receiving is proceeding in the direction of using integrated optics. This makes it possible to simplify the schemes of the line regenerators and receiving and transmitting equipment. It also makes them reliable and economical. Transmission systems with coherent radiators and receivers are being developed. Spectral multiplexing will make it possible to increase the carrying capacity of optical transmission paths. Signals will be amplified and converted at optical frequencies. Acoustic [text missing in original source] will be developed.

Optical systems and cables are not only used to organize local and optical converters that convert audible signals into optical signals.

The creation of a multipurpose information communications system that, as a result of its use of the optical range, will make it possible for users to receive supplementary services (custom television, videophone, access to libraries and data banks, etc.) will mark a new stage.

The growth rates (40 percent annually) of fiber optics and the production of optical cables in the world market is advancing the rates at which all other branches of technology are being developed. A number of countries intend to cease using traditional metal cables within the next few years, and all new construction will shift to optical cables.

In the Soviet Union all works dealing with the creation of optical fibers and optical cables are coordinated by the Light Pipe [Svetovod] Interbranch Scientific-Technical Complex, whose general director is I.B. Peshkov. The scientific production association [NPO] of the All-Union Cable Industry Scientific Research Institute [VNIIKP], Cable Industry Special Design Office [OKB KP], and cable plants are developing and manufacturing cables. The IOFAN [not further identified] and Radio Engineering and Electronics Institute [IRE] of the USSR Academy of Sciences are creating low-loss light pipes, the Central Communications Scientific Research Institute [TsNIIS] is working on problems affecting fiber optic communications lines and on introducing such lines, and the enterprise USSR Ministry of the Electrical Equipment Industry [MEP] is creating optoelectronic devices. The Main Administration for the Construction of Communications Equipment [Glavsvyazstroy], Moscow Telephone Construction Trust [Mostelefonstroy], and All-Union State Long-Distance Wire Communications Equipment Construction Trust [Mezhgorsvyazstroy] all have experience in constructing fiber optic communications lines.

In the current five-year-plan, our country will see the further development of both local and long-distance communications, and a long trunk based on single-mode optical cables will be constructed. Fiber optic communications lines will be installed in ever-increasing volumes.

The main problem today is that of developing the mass production of high-quality low-loss optical fibers, particularly for single-mode cables. This will entail no small difficulties, especially from the standpoint of the quality with which rods are manufactured and the lack of specialized equipment and measuring instruments—both for producing cables and laying and operating

them. These difficulties have been clearly identified in the 26 February 1988 edition of PRAVDA in A. Tarasov's article entitled "Paradoxes of the Light Pipe."

Since 1975, the journal ELEKTROSVYAZ has regularly published articles dealing with optical communications systems. The first thematic edition completely devoted to this topic was published in 1980. Such thematic issues and sections were subsequently published as well (Nos 1 and 6 in 1981, No 12 in 1982, Nos 4 and 9 in 1984, Nos 10 and 12 in 1985, and Nos 2 and 4 in 1986. More than 120 articles dealing with fiber optic communications lines have been published in all.

The present thematic section together with the results of theoretical and experimental research on optical cables, equipment, and transmission systems will, for the first time, generalize our country's experience in the creation of fiber optic communications lines and will formulate the problems entailed in developing this branch of technology.

The editorial staff received a great number of articles that were specially prepared for this section. It is, of course, impossible to publish all of them in a single issue. This thematic section will be continued in the next few issues. It is planned that the problems of designing optical cables, constructing local lines, the assembly and measurement as well as the operation of fiber optic communications lines, and the foreign experience with fiber optic communications lines will be discussed. I.I. Grodnev is the curator of this thematic section.

12794

State of Art and Prospects for Development of Optical Communications Cables

18600082b Moscow ELEKTROSVYAZ in Russian
No 3, Mar 88 pp 2-3

[Article by I. B. Peshkov]

[Text] The Main Directions of the Economic and Social Development of the USSR for the Years Between 1986 and 1990 and the Period up Until the Year 2000 calls for the extensive development of the highly automated production of optical communications cables. The special urgency and great economic significance of this task lies in the fact that optical cables, as is well known, have a number of fundamental advantages over electric cables—a significantly higher carrying capacity and noise immunity, small overall dimensions and mass. They also make it possible to conserve copper, which is in short supply.

It is possible to confirm that the speed and volumes at which information can be transmitted currently determine the rates of scientific-technical progress. The possibilities of sharply increasing the flow of information is, at present, being most fully realized by switching over to using optical cable communications lines as opposed to traditional lines. This trend is characteristic of all of the world's technologically advanced countries.

In the USSR, particular experience has been accrued in the production of optical cables and the construction of fiber optic communications lines [VOLS] based on them. In different regions of the country fiber optic communications lines are used for long-distance and local communications, and work is underway to create extended fiber optic trunks.

Three areas in which optical cables can be efficiently used have been identified and characterized.

The first is that of using optical cables to configure connecting lines between automatic telephone exchanges [ATS] and communications nodes. These optical cables have been designed to transmit information over short distances (up to 10 km), and they operate without intermediate line regenerators. The optical cables that have been developed for local telephone networks have four or eight fibers, each of which is laid in a free-standing polymer tube—a so-called module. Together with the their reinforcing components, the modular elements are twisted into a core, above which a polyethylene jacket has been applied. To protect the cable from water penetration, the core is filled with a hydrophobic compound. This cable is intended to be laid in a cable-conduit system.

The main characteristics of optical cables are as follows: attenuation constant, 3 to 5 dB/km at a wavelength of 0.8 μm; bandwidth, 250 to 500 MHz; operating temperature range, minus 40 to plus 50 °C.

This type of optical cable has been laid in Moscow, the Moscow oblast, Leningrad, Gorkiy, and other cities.

A second area in which optical cables are used is local communications lines linking oblast centers with rayon cities under the jurisdiction of the oblast. As a rule, the distance of communications is within the limits of 100 km. Optical channels intended for local communications are being manufactured in two designs: modular channels (on the principle of the analogous design of optical cables for municipal communications) and channels based on a profiled core in which each fiber is laid in recesses in the core.

The main characteristics of optical cables for local communications are as follows: number of fibers, 4 or 8; attenuation constant, 0.7, 1.0, and 1.5 dB/km at a

wavelength of 1.3 μm ; bandwidth, 500 to 800 mHz x km; allowable tension, 1,000 N/cm; operating temperature range, minus 40 to plus 55 °C; construction length, not less than 2,000 m.

The 120-km-long Leningrad-Sosnovyy Bor line, which was recently put into operation, is an example of the use of fiber optic communications lines for local communications. The distance between regeneration points is 25 km, the mean attenuation of 1 km of line is not more than 0.8 dB. The laying of the cable is both manual and mechanized, and it is laid both in soil and in a cable-conduit system. Trunk communications lines based on optical cables make it possible to transmit information over very great distances (1,000 km or more) and to derive a great number of channels. Work to create such cables is being completed. Single-mode cables are being completed. Information is transmitted at wavelengths of 1.3 and 1.55 μm. The transmission system is an IKM-1920. The distance between regenerators is between 30 and 70 km (or more). The attenuation factor is between 0.3 and 0.7 dB/km. The standard frost resistance requirement for the USSR, minus 40 °C, has been maintained.

The development of optical cables, their launch into production, and their laying and operation were all made possible by the joint work of a number of institutes of the USSR Academy of Sciences and enterprises of the USSR Ministry of the Electrical Equipment Industry, USSR Ministry of Construction Materials, and USSR Ministry of Communications, as well as by the active assistance of a number of other ministries and departments.

To coordinate the operations entailed in creating and organizing the series production of quartz rods and optical fibers and cables that are on a par with the world technical level and whose production is based on advanced industrial technology, the Interbranch Scientific-Technical Complex [MNTK] Light Pipe [Svetovod] was reorganized in May 1987. The scientific production association [NPO] of the All-Union Cable Industry Scientific Research Institute of the USSR Ministry of the Electrical Equipment Industry has been designated as its head organization. The General Physics Institute (USSR Academy of Sciences), which is headed by academician A.M. Prokhorov, has been given the responsibility of the scientific direction of all of the work that must be done for the MNTK to accomplish its overall mission, the creation of promising quartz rods and optical fibers, progressive technologies and prototypes of the equipment needed to produce them, and the very rapid introduction of the results obtained at the enterprises.

The Quartz Glass State Scientific-Research Institute [GosNIIKS] of the USSR Ministry of the Construction Materials Industry, a number of institutes of the USSR Ministry of the Chemical Industry, and enterprises of other ministries are working on creating high-quality quartz rods.

Within the framework of the MNTK, fundamental research is underway, methods are being developed to increase the reliability and make an accelerated forecast of the life of optical fibers and increase fibers' mechanical strength to 70 N and their life to 25 years, and the effect of climatic and other factors on the optical characteristics of fibers and cables in the minus 70 to plus 250 °C range are being studied. Optical cables with single-mode fibers, low dispersion distortions, and a large signal transmission range have become widely popularized. These optical cables have commanded special attention; prototypes of single-mode optical cables with an attenuation constant of 0.37 dB at a wavelength of 1.3 μm and 0.22 dB at a wavelength of 1.55 μm have been produced.

A highly productive technology of manufacturing quartz rods is being created, and a technology for manufacturing rods and stretching anisotropic single-mode optical fibers while preserving their polarization has been developed. The production of quartz support pipes intended for use in manufacturing rods is being completed. Materials that make it possible to operate optical cables without any increase in attenuation at minus 40 °C and, in some cases, down to minus 60 °C, have been created.

The main tasks lying ahead in the area of creating and producing optical communications cables are as follows:

—switch over to using single-mode optical fiber instead of the currently used fibers, whose refractive index has a sloping profile;

—stop all use of the 0.85 μm wavelength to transmit information and switch to a wavelength of 1.3 μm and later to 1.55 μm;

—mass produce optical fibers with low attenuations (less than 0.3 dB/km);

—make optical cables frost, moisture, and lightning resistant;

—develop a technology to manufacture rods for optical cables.

The tasks entailed in improving and expanding the production of equipment for transmission systems for optical communications lines and testing and measuring equipment as well as systems and network problems are being addressed at the same time. A great deal of attention is being paid to organizing procedures for increasing personnel qualifications and to gaining experience in laying and operating optical communications cables.

Between 1988 and 1990 optical communications cables must be introduced on a wide scale and a transition to the next level of quality must be effected.

12794

Design of Domestic Local and Municipal Optical Cables

18600082c Moscow ELEKTROSVYAZ in Russian No 3, Mar 88 p 4

[Article by S. G. Akopov]

[Text] Designs for optical cables for various control nodes and communications networks have been developed in the USSR.

Domestic cables for local (intraoblast) communications [VZS] are manufactured in accordance with TU-16.705.455-87, and those for municipal telephone exchanges [GTS] are manufactured in accordance with TU-16.705.296-86. Local communications cables are intended to be laid in soil. Steel armoring wire is placed on top of the core along with copper conductor for the remote electric power supply of the regeneration points. Municipal communications cables are laid in a cable-conduit system and are manufactured without metal components.

Tables 1 and 2 present the main data on optical cables. Figure 1 illustrates the design of the optical cables (Figure 1a depicts cable intended for municipal telephone exchanges, whereas Figure 1b illustrates cable used for local communications).[Tables 1 and 2 not reproduced]

12794

Accelerated Quality Control of Radio Communication Apparatus

18600018a Kiev MEKHANIZATSIYA I AVTOMATIZATSIYA UPRAVLENIYA in Russian No 3, Jul-Sep 87 (manuscript received 18 Dec 86) pp 54-56

[Article by A. A. Sikarev, doctor of technical sciences, and V. V. Fedorenko]

[Abstract] A composite indicator of signal quality is proposed for accelerating the quality control of radio communication apparatus on the production line. This indicator, a coefficient analogous to the signal-interference discrimination coefficient, characterizes the relative overlap of monitored signal and standard signal in the frequency-time domain. This coefficient is determined by and thus combines several apparatus performance parameters so that a single measurement replaces several ones and the inspection time is thus appreciably shortened while the instrumentation is simplified. The larger this coefficient is, accordingly, the less do the apparatus performance parameters deviate from their nominal values and a unity coefficient corresponds to full compliance with specifications. For inspection purposes, readings of this coefficient are first compared with its threshold value so as to verify that all apparatus performance parameters which determine it are within their tolerances and need not be measured individually. The instrument for measuring this coefficient consists of a phase shifter, two multipliers, two integrators, two squarers, one summator, a strobe, a normalizer, an analog-to-digital converter, and a reference-signal generator. Inspection and quality control on this basis can be automated with the aid of an Elektronika-60M microcomputer, a frequency synthesizer including a bank of reference oscillators, a set of low-frequency oscillators, a set of high-frequency oscillators, an antenna equivalent, a control module, an input-output device, and the overlap meter properly connected into the inspection system. Figures 2; references: 2 Russian.

02415/09599

Automated Technical Maintenance of K-60P Transmission Lines

18600018b Kiev MEKHANIZATSIYA I AVTOMATIZATSIYA UPRAVLENIYA in Russian No 3, Jul-Sep 87 (manuscript received 6 Jan 87) pp 56-58

[Article by I. I. Gnidenko, candidate of technical sciences, and Ye. N. Sazonov]

[Abstract] A system for automated technical maintenance of K-60P primary transmission lines in the Unified Automatic Communication Network must ensure continuous inspection including fault identification and location, continuous preventive measurement of the load level diagram, display and documentation of readings, interaction with its counterpart in the correspondent's station along a phantom communication channel, and periodic inspection of remote-control equipment. Such a system has been built for automated technical maintenance of 16 K-60P transmission lines with up to 128 line channels and up to 7 unattended repeater points each. The system consists of a signal switching and converting station with a monitoring and measuring panel. Components of the system include a multiplexer of analog signals, a bank of analog-to-digital converters with band filters for preliminary signal analysis and conversion, a demultiplexer of analog signals with a low-pass filter and a summator. Line channels are tested not only during periodic preventive inspection but also when the level of the test-frequency signal drops and upon request by the station operator or from the correspondent's station. The cost of such a system is estimated at 3,500 rubles, while a single remote-control terminal costs 1,500 rubles. Using one such system for 16 transmission lines will therefore save 20,500 rubles in investment cost alone. Figures 1; references: 3 Russian.

02415/09599

Equipment Complex for TVR Telegraph Channels With Time Division

18600051a Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 27 Mar 87) pp 4-7

[Article by V. I. Korol, B. V. Korop, I. S. Usov, Yu. P. Parkhomov, S. I. Martsenitsen, S. P. Volfbeyn, and V. A. Stepanets]

[Abstract] A new generation of channel equipment TVR for voice-frequency carrier telegraphy with time division of channels has been developed in the USSR and is now ready to be built on a commercial scale. The equipment complex is a modular one, with minimum number of different terminal modules. It consists of a 2.4 kbit/s multichannel telegraph muldex with modem, a 2.4 kbit/s multichannel statistical muldex with modem, a 9.6 kbit/s signal converter, a monitor-test panel, a group of single-channel subscriber sets, a voltage converter, all mounted in a bay, also autonomous single-channel audio-frequency and ultrasonic-frequency subscriber sets. The equipment can be powered with alternating current from one phase of a 187/242 V - 47.5/52.5 Hz distribution line, provided nonlinear distortion of the current waveform does not exceed 10 percent, with direct current from a -54/66 V battery, or with rectified current. Each component is functionally monitored, signalization being provided for indication of internal fault or undervoltage. The complex is designed for operation within a local sector, and for hookup to the nearest automatic telegraph network using pulse-code-modulation. Its manufacturing cost and operating cost are much lower than those of existing DUMKA and TT-144 voice-frequency carrier equipment, especially when the number of channels is increased. Its components are smaller and weigh less. Figures 4; references 2: Russian.

02415/09599

Increasing Efficiency of Automatic Sensitivity Control in Charge-Coupled-Device Video Signal Transducers

18600051b Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 5 Dec 86) pp 24-27

[Article by M. N. Stinov]

[Abstract] Automatic sensitivity control in charge-coupled-device arrays operating as video signal transducers is known to most effectively enhance their performance, namely to widen their dynamic range upward as well as downward, by varying the charge buildup time depending on the intensity of incident light and thus on the proportional to the latter magnitude of the video output signal. Such a control is implemented by a processor of the video signal which cuts out of it quenching pulses so as to make the control independent of the quenching signal, this processor being followed by a delay line which cuts in automatic control when the amplitude of the video signal exceeds a certain nominal reference level. The scheme includes, in addition to a reference-voltage generator and a comparator, also a scaling amplifier, a sampler-storage device, and a phase-voltage shaper. Following an analysis of this generalized ASC structure, sources of instability in it are identified on the basis of CCD characteristics. The theoretical results have been verified experimentally on a PZS K1200TsM1 intermediate-format CCD array with a Schneider-Kreuznach XENOPLAN-1.7/17 objective. Use of a reference voltage with a nonlinearly discretely variable waveform was found to widen the dynamic range of such a CCD array by more than 24 dB in the direction of higher illumination intensity so that manual irising of the camera objective may become unnecessary. Figures 4; references 5: 3 Russian, 2 Western (1 in Russian translation).

02415/09599

Dielectric Microwave Resonators in E-Plane Waveguide Structures

18600051c Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 6 Jun 86) pp 31-34

[Article by G. N. Shelamov]

[Abstract] A comparative design and performance evaluation of dielectric microwave resonators in E-plane planar microwave waveguide structures is made, a new basic configuration being considered in addition to conventional ones with such a resonator as inhomogeneity in a slotted line and in a microstrip line or as coupler between two waveguides. According to the new scheme, such a resonator is mounted on the surface of a dielectric substrate or coaxially in the hole of a metal or metal-dielectric composite plate. Altogether 16 variants of all configurations are shown and a general expression for their first resonance frequency is given for a cylindrical dielectric slug, this frequency representing an approximate solution to at applicable approximate transcendental equation. Theoretical design and performance parameters are compared respectively with practical dimensions and experimental performance data, measurements having been made in rectangular and circular waveguides. Use of such a resonator in microwave filters and Gunn-effect diode oscillators for improvement of their selectivity is considered and found to be feasible. Figures 3; tables 2; references 9: 8 Russian, 1 Western.

02415/09599

Automatic Monitor of Voltage Standing-Wave Ratio in Antenna-Waveguide Channel of Low-Noise Receivers Operating Without Break in Communication

18600051d Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 23 Jun 86) pp 35-38

[Article by K. N. Martyshevskiy and V. P. Mushkov]

[Abstract] An automatic monitor of the voltage standing-wave ratio in antenna-waveguide channels is proposed which measures this ratio on the input side of low-noise

receivers without interrupting communication. It consists of an FM test signal generator and a bifurcator followed by a switch, an attenuator, and a controlled commutator, also three directional couplers, another bifurcator, a mixer, and two detectors. Its performance in both monitoring and calibration modes is analyzed for accuracy. Together with a monitor of the amplitude-frequency characteristic, it should ensure satisfactory reliability of low-noise receivers. Addition of another commutator and another directional coupler so as to eliminate the need for separating channels and for preventive inspection would be desirable. Figures 5; references 7: all Russian.

02415/09599

Automatic Monitoring of Tolerance and Location of Faults in Digital Transmission Systems
18600051e Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 29 May 86) pp 40-45

[Article by S. S. Kogan]

[Abstract] Automatic monitoring of tolerance and location of faults in a digital television trunk are discussed from the standpoint of SECAM requirements, the two essential ingredients being analysis of test signals for errors in the system and synthesis of the control logic which will make straight-through monitoring feasible. Selection of optimum monitoring signals with a variation range from the top of line synchronization pulses rather than the black level to white is demonstrated, whereupon the monitoring procedure is reduced to calculating the difference between received signal and reference signal readings followed by comparing this difference with the width of the tolerance band. Figures 3; tables 2; references 10: 8 Russian, 1 Western (1 in Russian translation), 1 CCIR.

02415/09599

Method of Suppressing Aggregate Interference From Radiation Source and Passive Retransmitters
18600051f Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 19 May 86) pp 48-51

[Article by Ye. K. Levin and A. S. Nemirovskiy]

[Abstract] Suppression of the resultant interference voltage in output signals of two spaced receiver antennas picking up interference from an extraneous source and nearby passive retransmitters is considered, the method proposed here being installation of a transversal line filter behind the output of each antenna. Synthesis of such corrective filters with a frequency characteristic matching the interference spectrum by the simulation method with some unavoidable error of time delay realization is outlined, with a weighting summator included in the filter-compensator structure. Their efficiency is calculated as the minimum attainable interference-to-signal ratio at the compensator output. Calculations are shown for the worst case of an aggregate interference covering the entire spectrum of the useful signal and having a correlation interval not wider than that of the useful signal, assuming also realization of time delays with maximum errors on the plus side and on the minus side respectively in two channels which carry mutually noncorrelated interference signals. Figures 2; references 5: 4 Russian, 1 Western (in Russian translation).

02415/09599

Static Automatic Voice Data Transmitter RSA-64
18600051g Moscow ELEKTROSVYAZ in Russian
No 9, Sep 87 (manuscript received 8 Jul 86) pp 52-57

[Article by V. G. Orlov]

[Abstract] A new automatic voice data transmitter PSA-64 has been developed at the Moscow Institute of Electrical Communications Engineering for urban, long-distance, local, and business telephone networks. Its main feature is a static sound recording and playback system built with integrated-circuit chips. Its other components are an analog-to-digital and digital-to-analog conversion module, a semiconductor storage with addresser, a control and monitor module, and an electric power supply. The storage consists of four blocks, each a 16 kbit read-only memory containing 32 dynamic series K565 microcircuits with A0-A6 address inputs and RAS line indexing inputs as well as WE recording-playback inputs and D1 data inputs. The addresser to memory microcircuits contains a 5-digit decoder for parallel interrogation of corresponding microcircuits in the four read-only memories. The transmitter is assembled into a portable case with a keyboard for control of recording and playback levels, with digital indication, on the front panel. The power supply is assembled on two boards with hookup to a 220 V a.c. line or a 60 V d.c. station battery respectively. Figures 9; references 8: all Russian.

02415/09599

Calculation of Eddy Currents in Cylindrical Electromagnetic Shields of Finite Length

18600019a Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 6, Jun 87 (manuscript received 8 Jul 85 pp 5-10

[Article by Andrey Vladimirovich Shchulin, candidate of technical sciences, assistant, Leningrad Institute of Electrical Engineering]

[Abstract] An analytical method is proposed for approximately determining the armature reaction of a cylindrical shield of finite length in a three-dimensional magnetic field of a coaxial cylindrical current sheet. The shield is assumed to be thin and the current in the sheet around it is assumed to vary sinusoidally in time, its magnetic field being quasi-stationary. The current distribution on the inside surface of the sheet establishes a linear surface current density which depends on the gradient of that distribution and is a function of the radial coordinate. First is considered a shield of infinite length, for which the corresponding field problem is solved with the aid of Fourier-cosine integral transformation and by borrowing the superposition principle from circuit theory. A shield of finite length then corresponds to an open-ended segment between two semi-infinite ones. Numerical calculations by this method have been made for a commercial AO-72-2 induction motor with a hollow duralumin cylinder (outside radius 8.0 cm, wall thickness 1.0 cm) replacing the standard rotor inside the stator (inside radius 10.3 cm, length of core 33.5 cm, length of end turns 10.0 cm). The results, disregarding effects of the intrinsic magnetic field in the shield, are in close agreement both qualitatively and quantitatively with the results of measurements at 50 Hz line frequency. Figures 3; references 11: 9 Russian, 2 Western.

02415/09599

Reduction of Boundary-Value Problem for Electrostatic Field in Plate Made of Composite Material to Integral Equation

18600019b Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 6, Jun 87 (manuscript received 14 Jun 85 pp 11-15

[Article by Vitaliy Terentyevich Klimenko, candidate of physico-mathematical sciences, senior scientific associate, Institute of Problems in Materialogy, UkSSR Academy of Sciences]

[Abstract] A rectangular plate of a composite material and with electrical insulation along its four lateral edges is considered, the electrostatic field in such a plate being calculated by reduction of the corresponding boundary-value problem to a Fredholm integral equation of the second kind. This is done in a Cartesian system of coordinates with the origin at one corner of the plate and the three axes along the respective edges. The plate is assumed to be thin so that the problem becomes a two-dimensional one and the material is assumed to consist of a matrix with inclusions in the form of unidirectionally oriented fibers. The system of two differential field equations is first reduced to a system of integrodifferential ones for a biharmonic potential distribution, which allows introducing two sets of harmonic functions. Further reduction to the Fredholm integral equation with a readily integrable kernel is achieved with the aid of Green's second theorem, using also the Heaviside function and the theory of Fourier series. References: 3 Russian.

02415/09599

UDC 621.313.2

New Method of Configuring Commutation Field in Direct-Current Machine

18600078a Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 2, Feb 88 (manuscript received 17 Oct 86) pp 19-23

[Article by Igor Borisovich Bityutskiy, candidate of technical sciences, assistant professor Lipetsk Polytechnic Institute]

[Abstracvt] A new method of designing interpoles for direct-current machines is proposed, their essential two features being an asymmetric shape with different chambers on each side but alternate interpoles turned around so as to maintain mirror symmetry and lengthwise rather than transverse stacking of laminations so as to prevent an increase in magnetic-field pulsations in air gaps narrowers than those under the main poles. Adequate damping of eddy currents may require replacement of a few steel laminations with copper ones. A drawback of this design is that brushes of opposite polarities do not commutate identically, but this effect can be minimized by winding the armature with full-pitch coils and inserting a damper cage into its slots. These concepts are demonstrated on design and performance analysis of a 6,000 kW d.c. motor for rolling mills. Figures 7; reference 12: 8 Russian, 2 Czechoslovak, 2 Western (1 in Russian translation).

02415/06662

Setup for Bonding Optical Fibers

81442829 Moscow VESTNIK SVYAZI in Russian
No 4, Apr 88 pp 47-49

[Article by A. I. Rybyanets and V. A. Tikhonov, engineers, under the "From Science to Production" rubric: Setup for Bonding Optical Fibers"; first paragraph, VESTNIK SVYAZI introduction]

[Text] Beginning in 1987 the USSR Ministry of the Communications Industry organized the series production of the model KSS-111 setup for bonding optical fibers. The setup includes production equipment and tools for preparing optical cable for bonding and for bonding KKG-type quartz gradient optical fibers, which meet specifications TKhO.835.093 TU and TU 16.705.452-86. The setup (Figure 1) consists of devices for bonding optical fibers, an RO-1 device for cutting optical cable sheaths, an SO-2 tool for removing an optical cable's protective sheathing, an IR-1 tool for splitting optical cable, and auxiliary tools. A setup costs 6,900 rubles. [Figure 1 not reproduced]

The preparation of the optical cable for bonding begins with the removal of the outer sheathings. This is done by using a model RO-1 tool (Figure 2), which makes transverse, longitudinal, and (when necessary) spiral scores. The required length of cable is laid in the roller groove (1), and a button (2) is pressed to make the knife cut into the cable sheathing the specified depth. An arm (3) is placed in the position specifying the type of score. [Figure 2 not reproduced]

A model SO-2 tool is then used to remove the protective sheathings. First, special side knives are used to remove the modular tube. Next, profiled knives with a calibrated opening are used to remove the polyamide coating. Finally, thin polymer filaments (lines) enclosing the fiber are used to help remove the layer directly adjacent to the fiber (Figure 3). To accomplish this, a lever (2) is pressed to score the fiber's protective polyamide sheathing. The protective sheathing is removed by pulling the fiber (which is being held by a clamp) out of the tool. The fiber is fed into the bushing opening (8) and is clamped by a line (11) by turning a diaphragm (10). The fiber's inner coating is removed by carefully pulling it out of the tool. To keep the line from breaking, the coating is not completely removed (when necessary, the removal of the fiber's protective and inner coatings can be combined into a single operation). If the line breaks, the tool is serviced. [Figure 3 not reproduced]

The fiber is scored by using a model IR-1 tool and the controlled break method. First a cutter makes a flaw, and then the fiber is bent and stretched apart (Figure 4). The top of the tool (4) is pressed down to make the flaw in the fiber. The top is then released. The cutter is raised, and the fiber remains pressed to the plate (2). The fiber is broken by bending the base (1) sharply. When a cutter fails, it is replaced. [Figure 4 not reproduced]

Besides these special tools, the setup also includes a proportioning pump to feed alcohol to wipe the fiber clean and auxiliary all-purpose tools such as scissors, a tweezer, etc.

The prepared optical fibers are joined by an electric arc in a model KSS-111 alignment unit and bonding setup after having first been laid in V-shaped grooves and fixed in place by magnetic catches. The movable spring-loaded stops in the clamps and the design of the V-shaped grooves make it possible to fix different-diameter fibers (from 0.25 to 0.9 mm, depending on their protective coating).

The left fiber clamp may be moved in three coordinates and used to align fibers relative to one another and to shift them during manual bonding. The right clamp may only be moved along the fiber's axis and can shift the fibers in an automated mode on account of the thermal engine.

A model MIR-3 microscope, which is mounted on a carriage, is shifted from one extreme position to the other, which makes it possible to view the pair of fibers being aligned sequentially in two mutually perpendicular planes with a magnification of no less than 60 times. A light source with a diffuser is mounted in the electrode unit and provides a contrast image of the fibers in the microscope's field.

Two tungsten electrodes with bilateral grinding are mounted in the electrode unit, and the electrodes' position is regulated. The electrode unit may be moved in three coordinates, which makes it possible to place the electrodes in the plane of the fibers being aligned as well as symmetrically relative to the fibers.

The bonding unit's electrode circuit forms an electric discharge and also makes it possible to control the following parameters: the fusion and bonding current, the arcing time in a fusion and bonding mode, and the shift speed. Furthermore, in an automated mode, a thermal engine helps effect the timely shift of the fibers during bonding.

Included in the KS-111 is a subassembly to protect the optical fibers' bonding site by heat shrinkage. It consists of a heating element and a special attachment with grips for the fiber.

As its feed source the model KSS-111 setup can have an accumulator or other direct current source with a voltage of 12 plus or minus 2 V and with a load current of no less than 4 A.

The setup is designed for use in booths, under overhangs, and in underground cable conduit systems at an ambient air temperature ranging from -10 to +40 degrees C and relative humidity of no more than 98 percent at an ambient air temperature of +20 degrees C.

When its operator has the appropriate experience and observes its operating rules, the KSS-111 joins gradient optical fibers with losses of no more than 0.2 dB.

A setup of components to protect the bonding site [KDZS] that does not include a KSS-111 is used for subsequent finishing of the site at which the optical fiber has been bonded. The setup is ordered separately. Before the bonding takes place, the setup is slipped onto the left optical fiber. After the fibers have been bonded, the setup is moved into the bonding area and transferred to area where the heating element is located for shrinkage.

The KSS-111 setup is currently being widely used in the construction of fiber optic communications lines.

12794

UDC 621.375.826.008.03:389.14

Standardization of Meteorological Gas-Discharge Lasers

18600077a Moscow IZMERITELNAYA TEKHNIKA in Russian No 2, Feb 88 pp 20-23

[Article by M. N Burnashev, V. Ye. Privalov, and L. P. Tkachenko]

[Abstract] Standardization of meteorological lasers from the standpoint of their essentially small-scale production for special-purpose applications is proposed on the basis of available design and performance data, most of these lasers for measurements by interference methods being low-power (0.2-100 mW) single-mode or multimode continuous-wave gas-discharge lasers which feature high degrees of coherence and stability. Preferable are visible He-Ne lasers (630 nm wavelength), also useful being infrared He-Ne lasers (1,150 nm or 3,390 nm). The list of recommended lasers contains 40 models with their power rating, beam divergence, operating mode, weight including power supply and overall dimensions, service life ranging from 500 h to 20,000 h, also nominal as well as guaranteed maximum power, frequency, and polarization instabilities. The basic four types are the LG (630 nm and 1,150 or 3,390 nm) with external mirrors and with Brewster windows made of quartz glass, the LGN with internal mirrors, the ILGN modification, and the OKG "optical quantum generator" (630 nm only) with Brewster windows made of glass. Tables 4; references: 2 Russian.

02415/06662

UDC 535.231.13.08:778.33

Automatic Digital Calculator for Meter of Optical Density on X-Radiograms

18600077b Moscow IZMERITELNAYA TEKHNIKA in Russian No 2, Feb 88 pp 28-29

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[Abstract] A portable x-radiogram analyzer operating on the basis of the Bouguer-Lambert-Beer law has been designed which includes an automatic digital calculator with a temporary storage for log F_0 readings (F_0 - intensity of incident luminous flux). The instrument contains, in addition, a photoreceiver which converts light into electric signals, a logarithmic amplifier, a clock oscillator, and analog-to-digital converter, a commutator with a generator of switching pulses, and a selector for transfer from access mode to measure mode and back. In the fist mode incident light is measured directly and its intensity is indicated. In the second mode instantaneous readings are stored in counters of the temporary memory for subsequent calculations. The instrument can also measure negative optical density, when the reference light is weaker than the measured one as in the case of contrast determinations, and the difference of optical density at two points on an x-radiogram. The instrument can be calibrated against standard blackening gauges. Figures 2.

02415/06662